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Rio Blanco Oil Shale Project

PROGRESS REPORT 7-SUMMARY

March · April · May, 1976

Gulf Oil Corporation
and
Standard Oil Company (Indiana)
9725 East Hampden Avenue, Denver, Colorado 80231

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PROGRESS REPORT 7 - SUMMARY

TRACT C-a OIL SHALE DEVELOPMENT

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to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

July 31, 1976

by

RIO BLANCO OIL SHALE PROJECT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)

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INTRODUCTION

Rio Blanco Oil Shale Project (Gulf Oil Corporation and Standard Oil Company of Indiana), hereafter referred to in this report as RBOSP, is presenting it's seventh summary progress report for Tract C-a to the USGS Area Oil Shale Supervisor (AOSS). This report is a summary of work accomplished during the period March 1, 1976 through May 31, 1976. The baseline data gathered for the project are on file in the Area Oil Shale Supervisor's Office in Grand Junction, Colorado. These data and its interpretive text comprise Progress Report 7. This summary report presents an overview and highlights of these data and has been correlated to and organized consistent with Progress Report 7; that is, the numbering system and topic headings for the summary report is the same as that used in the Progress Report. For more detailed information the reader should refer to the Progress Report.

As has been done for Progress Reports 2 through 6, the numbering system for this report is consistent with those of the previous report. Therefore, a reader desiring information on the same subject in the previous reports (both Summary and Progress Reports) will find it under the same title heading and number. For this Progress Report, only those tasks are included for which activity was reported for the quarter. The table of contents for the Geotechnical Data Gathering Project lists only those programs that are still being worked; all other programs are complete. An index of all the tasks reported in previous progress reports is included in this section. The table of contents for the Environmental Baseline Data Gathering Project lists all the programs under investigation. Where programs indicate "no data collected", the numbers are left out of the text portion.

It should be noted that results of data taken during this quarterly reporting period but not available in time for this progress report will be included in the ensuing reports.

Additional information for the subjects covered in this progress report can be found in the following:

- Tract C-a Detailed Development Plan - March 1976
- Previous Progress Reports on file with the AOSS
- Annual Report - Tract C-a - Terrestrial Ecology Baseline Studies - March 1976
- Annual Report - Tract C-a - Aquatic Ecology Baseline Studies - March 1976

For general informational purposes in this report, two figures are shown. Figure 1 is a location map of Tract C-a showing major drainages, roads, towns and counties in the vicinity of the tract. Figure 2 shows Tract C-a in greater detail and generally locates the drill holes, stream gaging stations, air quality towers and roads.

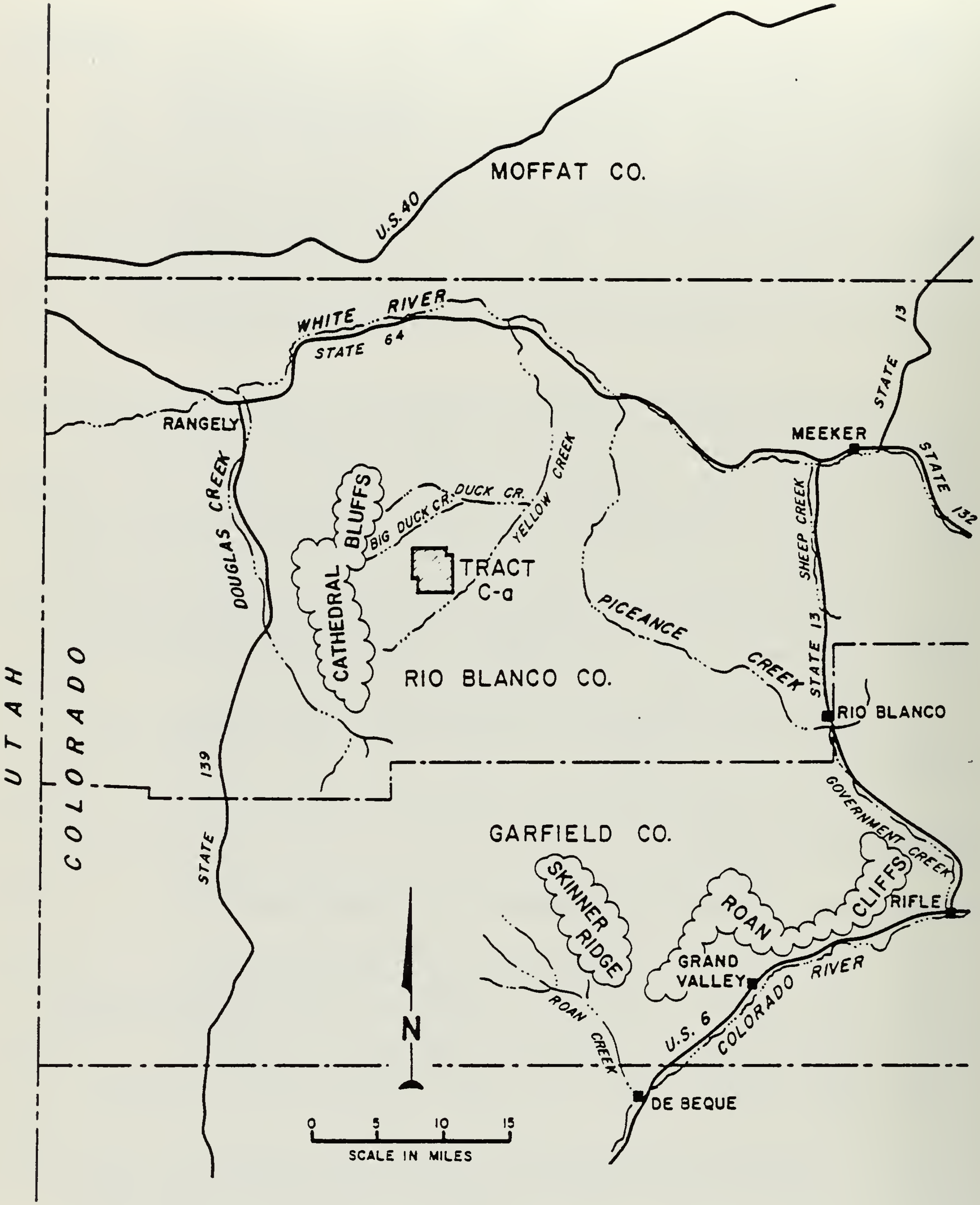

MOFFAT CO.
U.S. 40
WHITE RIVER
STATE 64
STATE 13
RANGELY
MEEKER
STATE 132
DOUGLAS CREEK
CATHEDRAL BLUFFS
BIG DUCK CR.
DUCK CR.
YELLOW CREEK
TRACT C-a
PICEANCE CREEK
SHEEP CREEK
STATE 13
RIO BLANCO
RIO BLANCO CO.
UTAH
COLORADO
STATE 139
GARFIELD CO.
GOVERNMENT CREEK
SKINNER RIDGE
ROAN CLIFFS
RIFLE
GRAND VALLEY
ROAN CREEK
U.S. 6
COLORADO RIVER
DE BEQUE
N
0
5
10
15
SCALE IN MILES

Figure 1

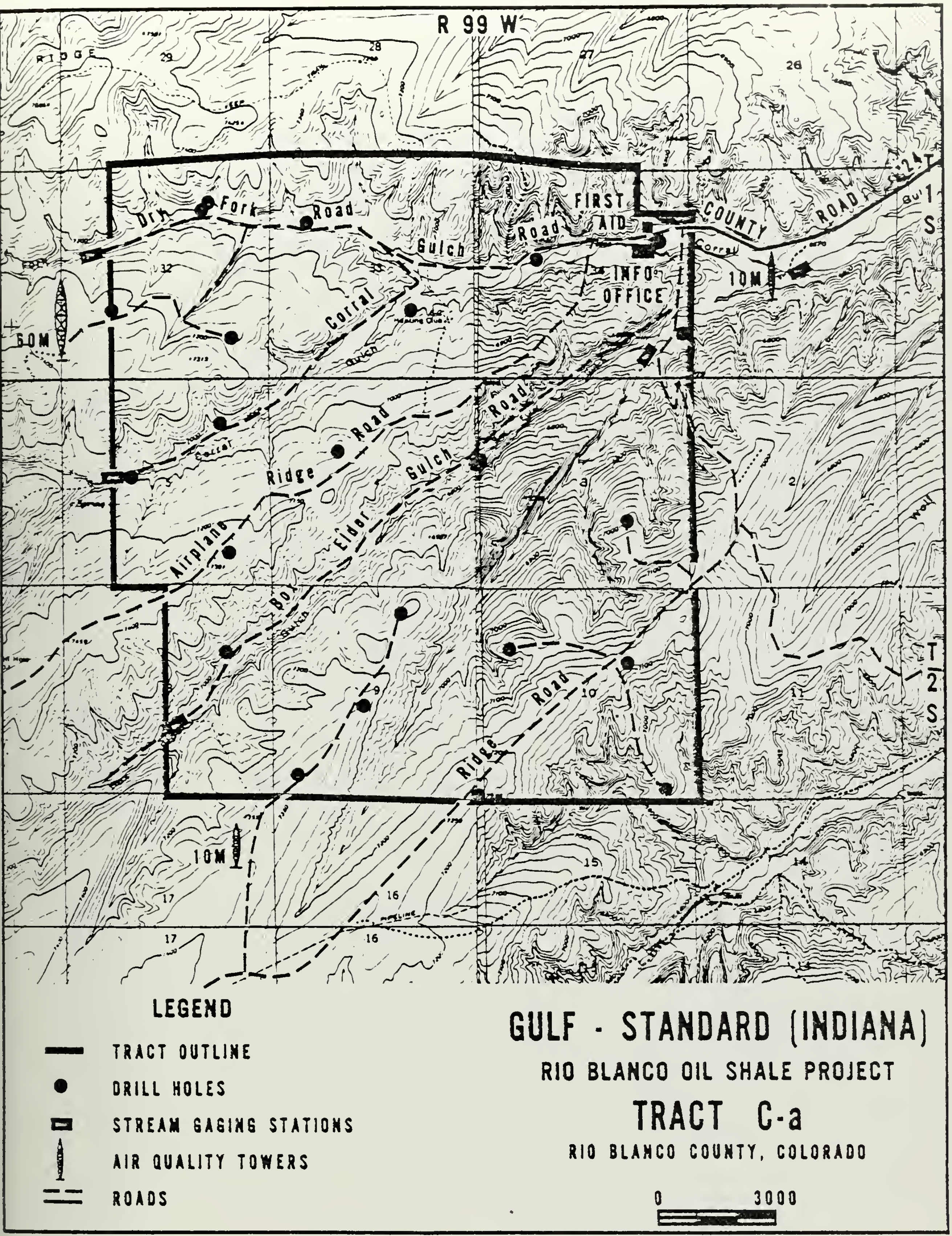

R 99 W
RIDGE
Dry Fork Road
Gulch Road
FIRST AID
COUNTY ROAD 24
INFO OFFICE
Corral Gulch
Corral
10M
60M
Ridge Road
Gulch Road
Corral Gulch
Airplane
Box Elder Gulch
Ridge Road
10M
T 1 S
T 2 S
28
29
27
26
32
33
2
9
10
11
15
14
16
17
PIPELINE
LEGEND
TRACT OUTLINE
DRILL HOLES
STREAM GAGING STATIONS
AIR QUALITY TOWERS
ROADS
GULF - STANDARD (INDIANA)
RIO BLANCO OIL SHALE PROJECT
TRACT C-a
RIO BLANCO COUNTY, COLORADO
0
3000

Figure 2

Geotechnical Data Gathering Project

ABSTRACT

The Geotechnical Data Gathering Project initiated by RBOSP on Tract C-a in the spring and summer of 1974 provides data required for engineering studies as well as data necessary to establish baseline conditions. The data gathering consisted of specific tasks conducted under the geologic program and the hydrologic program. Previous RBOSP progress reports were organized to allow reporting of the ongoing activities of each task. Presently most of the major tasks under both the geologic and the hydrologic programs have been completed and consequently, the organization of the geotechnical data gathering portion of the Progress Reports has been restructured to include only those tasks in which activity was reported during the quarterly reporting period.

Activities occurring under the geologic program during the quarterly reporting period involved: (1) revision of the tract stratigraphic correlation network and zonal resource maps based on new assay data in three coreholes, G-S 2-3, 4-5, and 6; and (2) transmitting 1,116 feet of split core from corehole G-S 7 to the USGS for quantitative trace element analyses.

Activities conducted under the hydrologic program were limited to the revised baseline monitoring program that has been approved by the AOSS. During the portion of the quarterly reporting period for which data is available, nine stream gaging stations reported flow. Some of these stations had not previously recorded a flow. The events causing the relatively rare flows are attributed to unseasonably high temperatures which caused intense snowmelting and resulted in rapid runoff. Data from the three recording type rain gages for the quarterly reporting period are summarized below.

Recording Type Rain Gage Locations	Monthly Average (Inches)	Total (Inches) for Quarter
Stake Springs Draw near confluence with Corral Gulch	1.14	3.42
Yellow Creek near White River	1.00	3.01
Cathedral Bluffs	1.30	3.90

The values on the table again demonstrate that the higher elevations in the Piceance Creek basin receive more precipitation than the lower elevations.

1.0 GEOTECHNICAL DATA GATHERING PROJECT

The geologic and hydrologic programs which make up the Geotechnical Data Gathering Project were initiated in the spring and summer of 1974. Both the geologic program and the hydrologic program are composites of a number of tasks as shown by the work breakdown structure, Figure 1.0-1. Nearly all of the tasks under both of the programs have been completed prior to this reporting period. Therefore, the Geotechnical Data Gathering Project portion of this progress report has been structured to include only the significant activities occurring during this quarterly reporting period.

Table 1.0-1 is an index in which significant activities related to the tasks and subtasks for each of the two programs are presented in previous progress report(s).

Activities occurring under the geologic program during the quarterly reporting period involved: (1) revision of the tract stratigraphic correlation network and zonal resource maps based on new assay data in three coreholes, G-S 2-3, 4-5, and 6; and (2) transmitting 1116 feet of split core from corehole G-S 7 to the USGS for quantitative trace element analyses.

Activities conducted under the hydrologic program were limited to the revised baseline monitoring program that has been approved by the AOSS. The revised program consists of: collection and analyses of monthly samples from stream gaging stations; continuous monitoring of flow rate, sediment discharge, temperature, and specific conductance at the stream gaging stations; monthly monitoring and recording water levels in alluvial holes; collection of water samples during the months of November, February, April, May, June, July, August, and September from the alluvial monitoring holes; collection of water samples, semi-annually, from the deep aquifer monitor holes; and measuring water levels monthly from the deep aquifer monitor holes. The last semi-annual water sampling period for the deep aquifers was March, 1976 and therefore will be reported in this progress report.

Figure 1.0 - 1

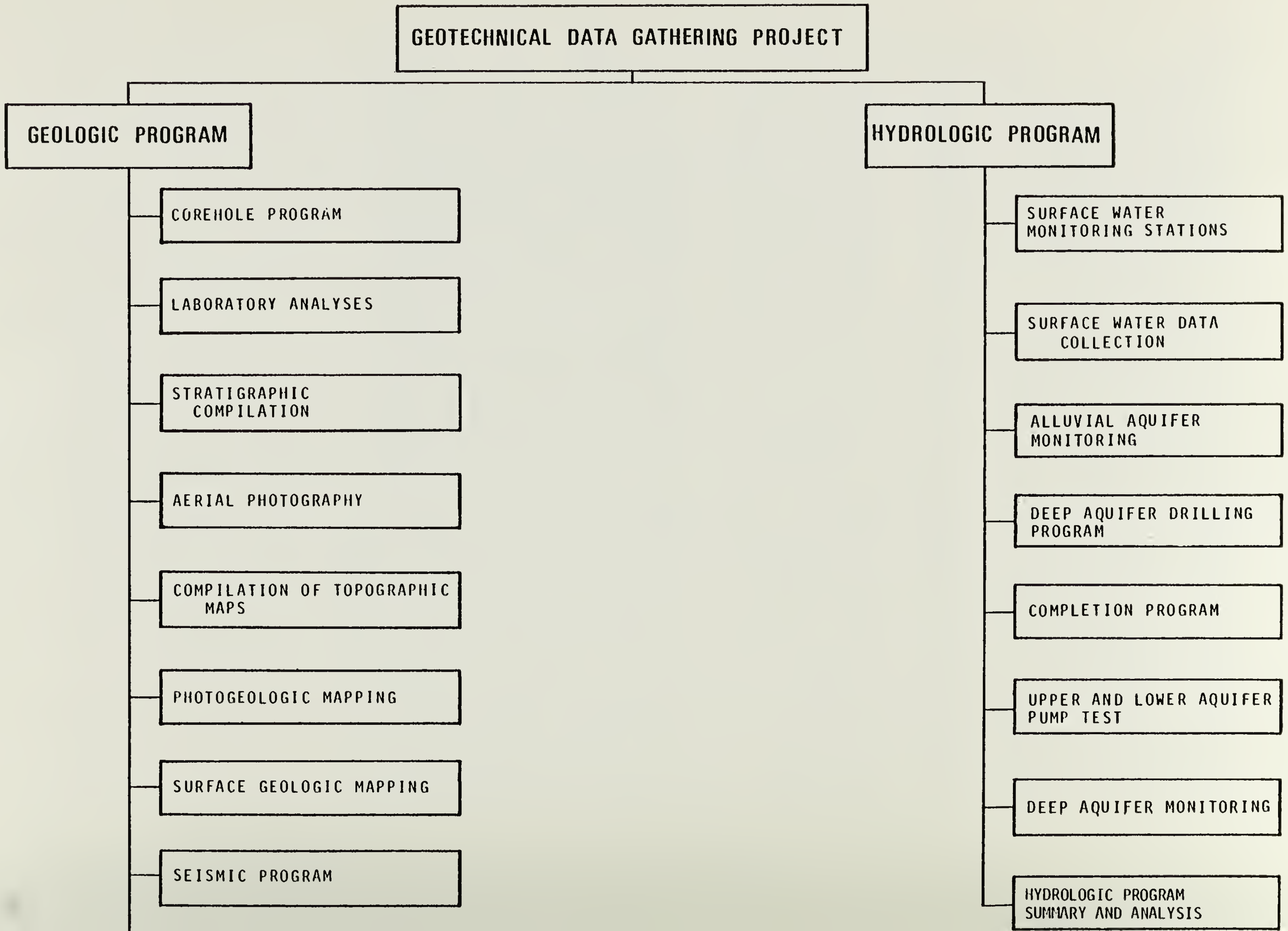

GEOTECHNICAL DATA GATHERING PROJECT
GEOLOGIC PROGRAM
COREHOLE PROGRAM
LABORATORY ANALYSES
STRATIGRAPHIC COMPILATION
AERIAL PHOTOGRAPHY
COMPILATION OF TOPOGRAPHIC MAPS
PHOTOGEOLOGIC MAPPING
SURFACE GEOLOGIC MAPPING
SEISMIC PROGRAM
HYDROLOGIC PROGRAM
SURFACE WATER MONITORING STATIONS
SURFACE WATER DATA COLLECTION
ALLUVIAL AQUIFER MONITORING
DEEP AQUIFER DRILLING PROGRAM
COMPLETION PROGRAM
UPPER AND LOWER AQUIFER PUMP TEST
DEEP AQUIFER MONITORING
HYDROLOGIC PROGRAM SUMMARY AND ANALYSIS

Table 1.0-1

INDEX OF TASKS REPORTED IN PREVIOUS PROGRESS REPORTS

Task		Progress Report(s)
1.1	Geologic Program	
1.1.1	Corehole Program	2
1.1.2	Laboratory Analyses	2,3,4,5,6
1.1.2.1	Oil Shale Assays	2,3,4,5,6
1.1.2.2	Nahcolite	2
1.1.2.3	Extractable Alumina	2
1.1.2.4	Trace Elements	2,3
1.1.2.5	Gas Samples	2
1.1.2.6	Rock Mechanics	2,5
1.1.3	Stratigraphic Compilation	3,4,5
1.1.4	Aerial Photography	2,4,5,6
1.1.5	Compilation of Topographic Mapping	2,4,5,6
1.1.6	Photogeologic Mapping	2
1.1.7	Surface Geologic Mapping	2
1.1.8	Seismic Program	2
1.1.9	Structural Compilation	2,5
1.2	Hydrologic Program	
1.2.1	Surface Water Monitoring Stations	2,3,4,5,6
1.2.2	Surface Water Data Collection	2,3,4,5,6
1.2.3	Alluvial Aquifers	2,3,4,5,6
1.2.4	Deep Aquifer Drilling Program	2,4,5
1.2.5	Deep Aquifer Completion	2,4
1.2.6	Upper and Lower Aquifer Pumping Tests	3,4
1.2.7	Deep Aquifer Monitoring	2,3,4,5,6
1.2.8	Hydrologic Program Summary and Analysis	4,5,6

1.1 Geologic Program

The activities occurring under the geologic program during the quarterly reporting period involved: (1) revision of tract stratigraphic correlations and zonal resource maps based on new assay data; and (2) transmittal of 1116 feet of core split to the USGS for quantitative analysis of nine trace elements. Other tasks for the most part have been completed. Table 1.0-1, page 1.0-3, is an index showing in which previous progress reports results of these tasks have been presented.

Revision of tract stratigraphic correlations and zonal resource maps was required when new Fischer assay data were obtained of core samples from the Gulf-Standard (Indiana) corehole program. The new assay data is a result of earlier check-assaying of 45 samples from coreholes G-S 4-5 and G-S 6 which indicated that the entire stratigraphic interval from the R-2 zone through the R-5 zone required reassaying in each of the holes. In addition to these reassays, short core intervals from holes G-S 2-3, and 6 which had been initially withheld from Fischer assay for rock mechanics testing were released for assay and the assays completed. This combination of new assay data constituted the basis for the geologic revisions.

The new assay dated resulted in slight revision of zonal boundaries in the northeast part of Tract C-a. It also caused zonal resource map changes in the same general area. Although some zonal oil shale grades changed significantly, the overall resources of the tract were only slightly affected because some zonal grade changes increased while others decreased, thereby compensating for one another.

Appropriate revisions were made to the tract correlation network which consists of density log cross sections and oil shale grade histogram log cross sections. Revised cross sections have been submitted to the AOSS.

A 1,116 foot core split from corehole G-S 7 was submitted to the USGS for quantitative analysis of nine specific trace elements. The nine trace elements are vanadium and molybdenum together with the following seven trace elements which were included in the original Rio Blanco analyses program: antimony, arsenic, boron, cadmium, fluoride, mercury and selenium. For the purpose of direct comparison between the results, the USGS analyses will be conducted on composite core intervals identical to those Rio Blanco had analyzed. The USGS will furnish representative and sufficient sized splits of the composite samples to Rio Blanco in the event that Rio Blanco should decide to run additional check- analyses on the composite splits. Additional checking, if done, may resolve variations in analysis results due to sample preparation,

sample contamination, difference in lab procedures, etc. At the end of this quarterly reporting period (May 31, 1976) trace element by the USGS were not completed. Results will be reported in future progress reports as they are obtained.

1.2 Hydrologic Program

Rio Blanco Oil Shale Project initiated surface water data collection and monitoring in March of 1974. Deep and alluvial aquifer data collection and monitoring was initiated in December 1974. These two main categories of tasks make up the Hydrologic Program that was implemented to establish baseline hydrologic conditions and to acquire data required for the design and planning of mine dewatering. The hydrologic tasks for which activity occurred during the quarterly reporting period are covered in RBOSP Progress Report 7, submitted in two parts: (1) Interpretive Text, and (2) Raw Data. Only those tasks for which activity occurred during the quarter are reported in this progress report summary. Table 1.0-1, page 1.0-3, shows in which progress reports significant activity for any specific task was reported.

1.2.1 Surface Water Monitoring Stations

RBOSP has contracted with the Colorado River Water Conservation District to have the Water Resources Division (WRD) of the United States Geological Survey (USGS) construct and operate surface water monitoring stations. Table 1.2-1 lists each of the eleven stream gaging stations and the six rain gaging stations, the USGS identification number, and a description of the location of each station. Figure 1.2-1 shows the location of the stream gaging stations and the rain gaging stations in addition to alluvial aquifer monitor holes.

1.2.2 Surface Water Data Collection

Due to the length of time required for processing and reporting data from the stream gaging stations, the progress reports generally include data from the previous quarterly reporting period and do not report data from the latter part of the quarterly period being reported. Table 1.2-2 is a data collection schedule for the stream gaging stations.

Stream gaging stations located along perennial reaches of streams which recorded flow during the quarterly reporting period included: Corral Gulch east of Tract C-a, Corral Gulch south of 84 Mesa, and Yellow Creek. No new data has been reported by the USGS-WRD for the stream gaging station located on Corral Gulch west of Tract C-a; however, the USGS-WRD has reported data for that gaging station which had not been processed in time for reporting in Progress Report 6. This new data, although covering Progress Report 6 reporting period, is presented in this progress report.

Table 1.2-1

LOCATION AND USGS IDENTIFICATION NUMBERS FOR SURFACE AND RAIN GAGING STATIONS

USGS Identification Number	LOCATION
09306237	Dry Fork near west line Tract C-a
09306235	Corral Gulch near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
09306241	"Rinky Dink" Gulch near east line Tract C-a
09306248	Upper Big Duck Creek north of 84 Mesa
09306250	Lower Big Duck Creek north of 84 Mesa
09306246	Tributary to Yellow Creek east of 84 Mesa
09306244	Corral Gulch south of 84 Mesa
	STORAGE-TYPE RAIN GAGES
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	RAINFALL INTENSITY AND RECORDING RAIN GAGES
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
No number	Cathedral Bluffs located in NW1/4, NW1/4, Sec. 14 T2S, R100W

Figure 1.2-1
STREAM GAGING STATIONS,
RAIN GAGING STATIONS
AND
ALLUVIAL AQUIFER MONITORING HOLES

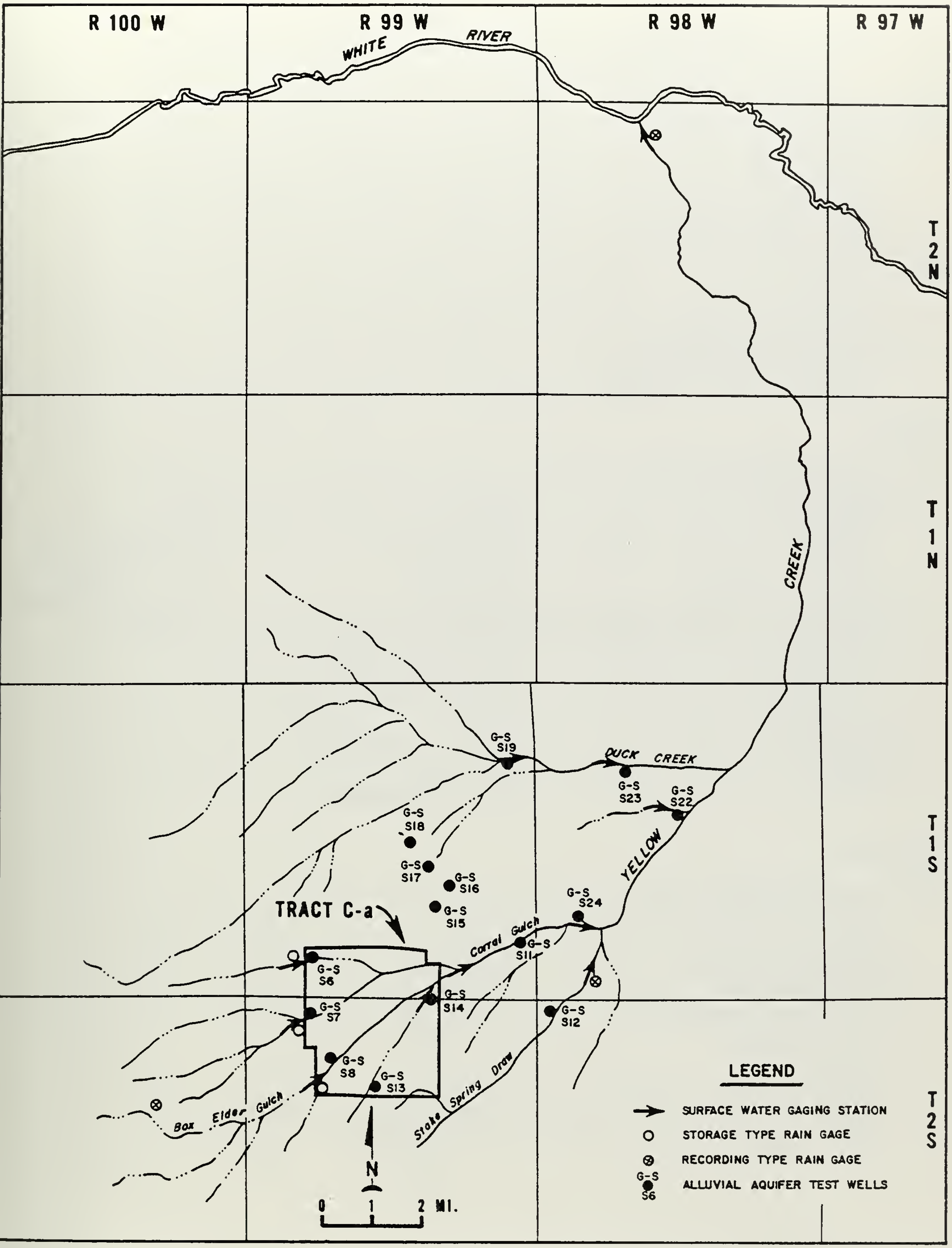


Table 1.2-2

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

Continuously or Automatically

- Flow Rate
- Sediment Discharge
- Temperature
- Specific Conductance

Periodically

- Storage Rain Gages
- Recording Rain Gages
- Rainfall Intensity Gages

Monthly

Water Samples Analyzed For:

- Alkalinity
- Biological Oxygen Demand
- Dissolved Organic Carbon
- Boron
- Calcium
- Conductance
- Fluoride
- Magnesium
- Potassium
- Silica
- Sodium
- Sulfate
- Ammonia
- Bicarbonate
- Carbonate
- Chloride
- Color
- Dissolved Solids
- Kjeldahl Nitrogen
- Nitrate plus Nitrite
- Odor
- Dissolved Phosphate
- Turbidity
- Dissolved Oxygen
- pH
- Temperature
- Total Phosphate
- Ortho Phosphate
- Suspended Organic Carbon

Quarterly

Sample and Analyze:

- COD
- Fecal Coliform
- Pesticides
- Polycyclic Aromatics
- Total Coliform
- Bromide
- Cyanide
- MBAS
- Oil & Grease
- Phenols
- Sulfide
- Radioactivity
  - Gross Alpha
    - 4 pci/l
    - Ra^{225}
  - Gross Beta
    - 100 pci/l
    - SR^{90}
    - Ce^{137}
- Ba
- Be
- Ge
- Ga
- Ni
- Ti
- V
- Zr
- Al
- As
- Cd
- Cr
- Cu
- Fe
- Pb
- Li
- Mn
- Mo
- Hg
- Se
- Sr
- Zn

During this quarterly reporting period and the latter part of the previous reporting period, flows were recorded at six of the stream gaging stations monitoring intermittent reaches. These stream gaging stations included: Box Elder Gulch near the west line Tract C-a; "Rinky Dink" Gulch near the east line of the tract; Stake Springs Draw near the confluence with Corral Gulch; Tributary to Yellow Creek east of 84 Mesa; and Upper and Lower Big Duck Creek north of 84 Mesa. The short duration flows at these stream gaging stations occurred three times during a period in February and March 1976. These three flow events were associated with unseasonally warm weather which may have caused intense snowmelting as evidenced by the close correlation of the flows between all of these stations. Table 1.2-3, shows the maximum and minimum discharge rates each month for the stream gaging stations reporting flow. More detailed flow data is presented in RBOSP Progress Report 7, Interpretive Text.

Summaries of the water quality analyses of water samples collected at the stream gaging stations reporting flow during the quarter are presented in Tables 1.2-4 to 1.2-13. Detailed water quality data is presented in the Interpretive Text and Raw Data portions of this progress report.

Precipitation data is collected by the USGS using three different types of rain gages, they are: the storage type rain gage; recording type gage, which measures precipitation daily; and the rainfall intensity gage, which records the time of each event and amount of precipitation during successive five minute time increments. Table 1.2-14 is a summary of the precipitation data for the quarterly reporting period. Additional data is presented in the Interpretive Text and Raw Data portions of this progress report.

1.2.3 Alluvial Aquifers

Fifteen alluvial aquifer test holes have been drilled on and around Tract C-a and 84 Mesa, the proposed processed shale and overburden disposal site. The holes which encountered water at the time they were drilled are: G-S S-7, G-S S-8, G-S S-11, G-S S-12, G-S S-19, G-S S-22, G-S S-23 and G-S S-24. Continuous water level recorders (Stevens Type F) were installed at G-S S-7, G-S S-8, G-S S-11, and G-S S-12.

Water level data, collected monthly, from the alluvial aquifer monitoring holes are summarized on Table 1.2-15. During this quarterly reporting period, the alluvial aquifer monitor holes

Table 1.2-3

MAXIMUM AND MINIMUM DISCHARGE (CFS) FOR STREAM GAGING STATIONS REPORTING FLOW DURING QUARTERLY REPORTING PERIOD

USGS Identification Number(1)	Jan.	Feb.	March	April	May
09306240					
Maximum	NF	0.06	0.40	0.45	---
Minimum	NF	NF	NF	NF	---
09306242					
Maximum	0.5	1.11	1.2	1.0(2)	---
Minimum	0.31	0.36	0.29	0.58(2)	---
09306244					
Maximum	0.05	0.95(3)	0.32	0.24(2)	---
Minimum	0.01	0.01(3)	0.15	0.19(2)	---
09306255					
Maximum	1.6(4)	3.60	3.9	2.7(2)	---
Minimum	0.9(4)	1.2	1.2	1.8(2)	---
09306241					
Maximum	NF	0.3	0.05	NF	---
Minimum	NF	NF	NF	NF	---
09306230					
Maximum	NF	1.58	1.48	NF	---
Minimum	NF	NF	NF	NF	---
09306246					
Maximum	NF	3.2	2.5	NF	---
Minimum	NF	NF	NF	NF	---
09306248					
Maximum	NF	0.4	0.7	NF	---
Minimum	NF	NF	NF	NF	---
09306250					
Maximum	NF	3.95	2.1	NF	---
Minimum	NF	NF	NF	NF	---

(1) Table 1.2-1 shows location of USGS I.D. Number
(2) Data not complete for month
(3) Flume washed out
(4) Readings effected by freezing
NF No Flow
--- Data not yet received

Table 1.2-4

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306230
STAKE SPRINGS DRAW NEAR CONFLUENCE WITH CORRAL GULCH
YEAR 1976

	Feb. 13										
1. Alkalinity (mg/l)	114										
2. Aluminum (ug/l)	100										
3. Ammonia (mg/l)	.14										
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	2										
6. Barium (ug/l)											
7. Beryllium (ug/l)											
8. Bicarbonate (mg/l)	139										
9. Bismuth (ug/l)											
10. Boron (ug/l)	160										
11. Cadmium (ug/l)											
12. Carbonate (mg/l)	0										
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	4.2										
15. Chromium (ug/l)											
16. Cobalt (ug/l)											
17. COD											
18. Coliform, Total & Fecal											
19. Color (PCU)	100										
20. Conductivity, Specific	280										
21. Copper (ug/l)											
22. Cyanide (mg/l)											
23. Discharge (CFS)											
24. Discharge, Instantaneous	.02										
25. Dissolved Oxygen (mg/l)											
26. Fluoride (mg/l)	.1										
27. Gallium (ug/l)											
28. Germanium (ug/l)											
29. Hardness (Ca, Mg) (mg/l)	0										
30. Hardness, Non-Carbonate (mg/l)	94										
31. Iron (ug/l)	180										
32. Kjeldahl Nitrogen (mg/l)	2.4										
33. Lead (ug/l)											
34. Lithium (ug/l)											
35. Magnesium (mg/l)	6.9										
36. Manganese (ug/l)											
37. Mercury (ug/l)											
38. Molybdenum (ug/l)											
39. Nickel (ug/l)											
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	.42										
43. Nitrogen, Ammonia	.11										
44. Odor (Severity)											
45. Oil & Grease (mg/l)											
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.16										
48. Pesticides	0										
49. pH	8.4										
50. Phosphorus, Total (mg/l)	.34										
51. Potassium (mg/l)	5.4										
52. Selenium (ug/l)											
53. Silica (mg/l)	5.3										
54. Silver (ug/l)											
55. Sodium (mg/l)	17										
56. Sodium Adsorption Ratio	.8										
57. Sodium ( )	27										
58. Solids, Dissolved (mg/l)	154										
59. Solids, Dissolved T/D	.01										
60. Solids, Dissolved T/Ac-Ft	.21										
61. Solids, Suspended											
62. Strontium (ug/l)	390										
63. Sulfate (mg/l)	17										
64. Sulfide (mg/l)											
65. Temperature (°C)	3.0										
66. Tin (ug/l)											
67. Titanium (ug/l)											
68. Turbidity (JTU)											
69. Vanadium (ug/l)											
70. Zinc (ug/l)											
71. Zirconium (ug/l)											
72. Calcium (mg/l)	26										
73. Complete Element Scan											
74. Radioactivity											
Gross Alpha (pCi)											
Radium 226*											
Gross Beta											
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	68.4										
If TOC 10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	67										
Organic Carbon, Suspended	1.4										
Phenols											
Sulfur (Acid Extraction)											
76 Total Ortho-Phosphorous (mg/l)	.16										
77 Phosphate	1.0										
78 Phosphorus, T[illegible] (mg/l)											

Table 1.2-5

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306235
CORRAL GULCH NEAR WEST LINE TRACT C-a
YEAR 1976

	Jan. 02										
1. Alkalinity (mg/l)	343										
2. Aluminum (ug/l)	30										
3. Ammonia (mg/l)	.12										
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4										
6. Barium (ug/l)	60										
7. Beryllium (ug/l)	<3										
8. Bicarbonate (mg/l)	418										
9. Bismuth (ug/l)	<15										
10. Boron (ug/l)	80										
11. Cadmium (ug/l)	7										
12. Carbonate (mg/l)	0										
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	11										
15. Chromium (ug/l)	<15										
16. Cobalt (ug/l)	<15										
17. COD	12										
18. Coliform, Total & Fecal											
19. Color (PCU)	5										
20. Conductivity, Specific	1100										
21. Copper (ug/l)	5										
22. Cyanide (mg/l)	.00										
23. Discharge (CFS)											
24. Discharge, Instantaneous	.50										
25. Dissolved Oxygen (mg/l)	11										
26. Fluoride (mg/l)	.3										
27. Gallium (ug/l)	<7										
28. Germanium (ug/l)	<40										
29. Hardness (Ca, Mg) (mg/l)	490										
30. Hardness, Non-Carbonate (mg/l)	140										
31. Iron (ug/l)	30										
32. Kjeldahl Nitrogen (mg/l)	.69										
33. Lead (ug/l)	<15										
34. Lithium (ug/l)	20										
35. Magnesium (mg/l)	60										
36. Manganese (ug/l)	20										
37. Mercury (ug/l)	.0										
38. Molybdenum (ug/l)	40										
39. Nickel (ug/l)	<15										
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	1.1										
43. Nitrogen, Ammonia	.09										
44. Odor (Severity)											
45. Oil & Grease (mg/l)	0										
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.00										
48. Pesticides	0										
49. pH	--										
50. Phosphorus, Total (mg/l)	.02										
51. Potassium (mg/l)	1.5										
52. Selenium (ug/l)	2										
53. Silica (mg/l)	19										
54. Silver (ug/l)	<2										
55. Sodium (mg/l)	84										
56. Sodium Adsorption Ratio	1.7										
57. Sodium ( )	27										
58. Solids, Dissolved (mg/l)	793										
59. Solids, Dissolved T/D	1.07										
60. Solids, Dissolved T/Ac-Ft	1.08										
61. Solids, Suspended											
62. Strontium (ug/l)	1300										
63. Sulfate (mg/l)	310										
64. Sulfide (mg/l)	.0										
65. Temperature (°C)	.5										
66. Tin (ug/l)	<15										
67. Titanium (ug/l)	<10										
68. Turbidity JTU)											
69. Vanadium (ug/l)	<15										
70. Zinc (ug/l)	10										
71. Zirconium (ug/l)	<40										
72. Calcium (mn/l)	95										
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pci)	<9.8										
Radium 226*											
Gross Beta	5.2										
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	16.5										
If TOC 10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	14										
Organic Carbon, Suspended	2.5										
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.00										
77. Phosphate	.06										
78. Phosphorus, Dissolved											

Table 1.2-6

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306240
BOX ELDER GULCH NEAR WEST LINE TRACT C-a
YEAR 1976

	Mar. 18										
Alkalinity (mg/l)	74										
Aluminum (ug/l)	40										
Ammonia (mg/l)	.32										
Aromatics, Polycyclic											
Arsenic (ug/l)											
Barium (ug/l)	50										
Beryllium (ug/l)	<1										
Bicarbonate (mg/l)	90										
Bismuth (ug/l)	<4										
Boron (ug/l)	110										
Cadmium (ug/l)	1										
Carbonate (mg/l)	0										
Carbon Dioxide (mg/l)											
Chloride (mg/l)	3.0										
Chromium (ug/l)	0										
Cobalt (ug/l)	<3										
COD	100										
Coliform, Total & Fecal											
Color (PCU)	100										
Conductivity, Specific	400										
Copper (ug/l)	13										
Cyanide (mg/l)	.00										
Discharge (CFS)											
Discharge, Instantaneous	.01										
Dissolved Oxygen (mg/l)											
Fluoride (mg/l)	.1										
Gallium (ug/l)	<1										
Germanium (ug/l)	<3										
Hardness (Ca, Mg) (mg/l)	65										
Hardness, Non-Carbonate (mg/l)	0										
Iron (ug/l)	280										
Kjeldahl Nitrogen (mg/l)	30										
Lead (ug/l)	13										
Lithium (ug/l)	10										
Magnesium (mg/l)	5.4										
Manganese (ug/l)	30										
Mercury (ug/l)	.0										
Molybdenum (ug/l)	3										
Nickel (ug/l)	<3										
Nitrate (mg/l)											
Nitrite (mg/l)											
Nitrite Plus Nitrate (mg/l)	.23										
Nitrogen, Ammonia	.25										
Odor (Severity)											
Oil & Grease (mg/l)	2										
Ortho-Phosphate (mg/l)											
Ortho-Phosphorus (mg/l)	.35										
Pesticides	0										
pH	8.1										
Phosphorus, Total (mg/l)	.83										
Potassium (mg/l)	11										
Selenium (ug/l)	0										
Silica (mg/l)	3.2										
Silver (ug/l)	0										
Sodium (mg/l)	2.7										
Sodium Adsorption Ratio	.1										
Sodium ( )	7										
Solids, Dissolved (mg/l)	95										
Solids, Dissolved T/D	.00										
Solids, Dissolved T/Ac-Ft	.13										
Solids, Suspended											
Strontium (ug/l)	190										
Sulfate (mg/l)	5.5										
Sulfide (mg/l)	.2										
Temperature (°C)	3.0										
Tin (ug/l)	<5										
Titanium (ug/l)	<1										
Turbidity (JTU)											
Vanadium (ug/l)	<3.0										
Zinc (ug/l)	30										
Zirconium (ug/l)	<5										
Calcium (mg/l)	17										
Complete Element Span											
Radioactivity											
Gross Alpha (pci)											
Radium 226*											
Gross Beta											
Thorium 230**											
Uranium**											
Total Organic Carbon (mg/l)	36.4										
If TOC 10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	34										
Organic Carbon, Suspended	2.4										
Phenols											
Sulfur (Acid Extraction)											
Total Ortho-Phosphorous (mg/l)	.35										
Phosphate	2.5										
Phosphorus, Dissolved											

Table 1.2-7

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306241
"RINKY DINK" GULCH NEAR EAST LINE TRACT C-a
YEAR 1976

	Feb. 13										
1. Alkalinity (mg/l)	73										
2. Aluminum (ug/l)	250										
3. Ammonia (mg/l)	.12										
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	3										
6. Barium (ug/l)	0										
7. Beryllium (ug/l)											
8. Bicarbonate (mg/l)	89										
9. Bismuth (ug/l)											
10. Boron (ug/l)	100										
11. Cadmium (ug/l)	1										
12. Carbonate (mg/l)	0										
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	1.8										
15. Chromium (ug/l)	0										
16. Cobalt (ug/l)											
17. COD	240										
18. Coliform, Total & Fecal											
19. Color (PCU)	280										
20. Conductivity, Specific	160										
21. Copper (ug/l)	13										
22. Cyanide (mg/l)	.00										
23. Discharge (CFS)											
24. Discharge, Instantaneous	.43										
25. Dissolved Oxygen (mg/l)											
26. Fluoride (mg/l)	.3										
27. Gallium (ug/l)											
28. Germanium (ug/l)											
29. Hardness (Ca, Mg) (mg/l)	37										
30. Hardness, Non-Carbonate (mg/l)	0										
31. Iron (ug/l)	280										
32. Kjeldahl Nitrogen (mg/l)	1.1										
33. Lead (ug/l)	10										
34. Lithium (ug/l)	10										
35. Magnesium (mg/l)	2.2										
36. Manganese (ug/l)											
37. Mercury (ug/l)	.1										
38. Molybdenum (ug/l)											
39. Nickel (ug/l)											
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42 Nitrite Plus Nitrate (mg/l)	.72										
43. Nitrogen, Ammonia	.09										
44 Odor (Severity)											
45. Oil & Grease (mg/l)											
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.08										
48. Pesticides											
49. pH	8.5										
50. Phosphorus, Total (mg/l)	.70										
51 Potassium (mg/l)	2.3										
52 Selenium (ug/l)	0										
53 Silica (mg/l)	5.0										
54 Silver (ug/l)											
55 Sodium (mg/l)	24										
56 Sodium Adsorption Ratio	1.7										
57. Sodium (%)	57										
58. Solids, Dissolved (mg/l)	102										
59. Solids, Dissolved T/D	.12										
60. Solids, Dissolved T/Ac-Ft	.14										
61 Solids, Suspended											
62. Strontium (ug/l)	100										
63. Sulfate (mg/l)	6.8										
64. Sulfide (mg/l)											
65. Temperature (°C)	1.0										
66. Tin (ug/l)											
67. Titanium (ug/l)											
68. Turbidity (JTU)											
69. Vanadium (ug/l)											
70. Zinc (ug/l)	90										
71. Zirconium (ug/l)											
72. Calcium (mg/l)	11										
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pci)											
Radium 226*											
Gross Beta											
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	70.9										
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	67										
Organic Carbon, Suspended	3.9										
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.08										
77. Phosphate	2.1										
78. Phosphorus, Dissolved											

Table 1.2-8

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306242
CORRAL GULCH EAST OF TRACT C-a
YEAR 1976

	Jan. 29	Feb. 18	Mar. 11								
1. Alkalinity (mg/l)	362	414	419								
2. Aluminum (ug/l)	10	10	20								
3. Ammonia (mg/l)											
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4	4	6								
6. Barium (ug/l)			60								
7. Beryllium (ug/l)			<4								
8. Bicarbonate (mg/l)	441	505	511								
9. Bismuth (ug/l)			<25								
10. Boron (ug/l)	140	120	100								
11. Cadmium (ug/l)			1								
12. Carbonate (mg/l)	0	0	0								
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	10	9.4	12								
15. Chromium (ug/l)			<20								
16. Cobalt (ug/l)			<20								
17. COD			12								
18. Coliform, Total & Fecal			2								
19. Color (PCU)	3	4	4								
20. Conductivity, Specific	1200	1300	1250								
21. Copper (ug/l)			3								
22. Cyanide (mg/l)			.00								
23. Discharge (CFS)											
24. Discharge, Instantaneous	.42	.55	.35								
25. Dissolved Oxygen (mg/l)	7.7	10.9	10.0								
26. Fluoride (mg/l)	.4	.4	.4								
27. Gallium (ug/l)			<7								
28. Germanium (ug/l)			<20								
29. Hardness (Ca, Mg) (mg/l)	470	460	520								
30. Hardness, Non-Carbonate (mg/l)	110	42	89								
31. Iron (ug/l)	10	10	<20								
32. Kjeldahl Nitrogen (mg/l)	.40	.22	.11								
33. Lead (ug/l)			<20								
34. Lithium (ug/l)			20								
35. Magnesium (mg/l)	63	60	70								
36. Manganese (ug/l)			40								
37. Mercury (ug/l)			.0								
38. Molybdenum (ug/l)			50								
39. Nickel (ug/l)			<20								
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	34	.37	.33								
43. Nitrogen, Ammonia	.04	--	.04								
44. Odor (Severity)											
45. Oil & Grease (mg/l)			0								
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.01	.05	.01								
48. Pesticides											
49. pH	7.8	8.2	7.7								
50. Phosphorus, Total (mg/l)	.00	.03	.04								
51. Potassium (mg/l)	1.5	1.4	1.7								
52. Selenium (ug/l)			<2								
53. Silica (mg/l)	20	20	21								
54. Silver (ug/l)			<2								
55. Sodium (mg/l)	110	100	120								
56. Sodium Adsorption Ratio	2.2	2.0	2.3								
57. Sodium (%)	34	32	34								
58. Solids, Dissolved (mg/l)	821	787	872								
59. Solids, Dissolved T/D	.93	1.17	.82								
60. Solids, Dissolved T/Ac-Ft	1.12	1.07	1.19								
61. Solids, Suspended											
62. Strontium (ug/l)	2000	1800	1700								
63. Sulfate (mg/l)	310	260	300								
64. Sulfide (mg/l)			.0								
65. Temperature (°C)	8.5	.0	9.0								
66. Tin (ug/l)			<20								
67. Titanium (ug/l)			<10								
68. Turbidity JTU)											
69. Vanadium (ug/l)			<10								
70. Zinc (ug/l)			10								
71. Zirconium (ug/l)			<30								
72. Calcium (mg/l)	85	83	91								
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pci)											
Radium 226*											
Gross Beta											
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	14.3	7.0	4.5								
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	14	6.7	4.2								
Organic Carbon, Suspended	.3	.3	.3								
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l	.01	.05	.01								
77. Phosonate	.00	.09	.12								
78. Phosphorus, Dissolved											

Table 1.2-9

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306244
CORRAL GULCH SOUTH OF 84 MESA
YEAR 1976

	Jan. 29	Feb. 18	Mar. 11							
1. Alkalinity (mg/l)	523	505	489							
2. Aluminum (ug/l)	10	10	<20							
3. Ammonia (mg/l)										
4. Aromatics, Polycyclic										
5. Arsenic (ug/l)	2	2	4							
6. Barium (ug/l)			200							
7. Beryllium (ug/l)			<5							
8. Bicarbonate (mg/l)	638	616	596							
9. Bismuth (ug/l)			<35							
10. Boron (ug/l)	180	160	150							
11. Cadmium (ug/l)			1							
12. Carbonate (mg/l)	0	0	0							
13. Carbon Dioxide (mg/l)										
14. Chloride (mg/l)	18	19	16							
15. Chromium (ug/l)			<25							
16. Cobalt (ug/l)			<25							
17. COD			26							
18. Coliform, Total & Fecal			94							
19. Color (PCU)	4	15	15							
20. Conductivity, Specific	1750	1900	1700							
21. Copper (ug/l)			2							
22. Cyanide (mg/l)			.00							
23. Discharge (CFS)										
24. Discharge, Instantaneous	.01	.10	.07							
25. Dissolved Oxygen (mg/l)	5.1	11.7	13.4							
26. Fluoride (mg/l)	.3	.4	.3							
27. Gallium (ug/l)			<10							
28. Germanium (ug/l)			<30							
29. Hardness (Ca, Mg) (mg/l)	730	690	680							
30. Hardness, Non-Carbonate (mg/l)	210	180	190							
31. Iron (ug/l)	20	30	<30							
32. Kjeldahl Nitrogen (mg/l)	.76	1.0	.96							
33. Lead (ug/l)			<25							
34. Lithium (ug/l)			10							
35. Magnesium (mg/l)	110	100	97							
36. Manganese (ug/l)			60							
37. Mercury (ug/l)			.0							
38. Molybdenum (ug/l)			60							
39. Nickel (ug/l)			<25							
40 Nitrate (mg/l)										
41. Nitrite (mg/l)										
42 Nitrite Plus Nitrate (mg/l)	.71	.85	.68							
43. Nitrogen, Ammonia	.05	.15	.08							
44 Odor (Severity)										
45. Oil & Grease (mg/l)			0							
46. Ortho-Phosphate (mg/l)										
47. Ortho-Phosphorus (mg/l)	.02	.01	.03							
48. Pesticides			0							
49. pH	7.8	8.2	8.3							
50. Phosphorus, Total (mg/l)	.00	.05	.06							
51 Potassium (mg/l)	2.6	2.7	3.0							
52 Selenium (ug/l)			2							
53 Silica (mg/l)	17	18	20							
54 Silver (ug/l)			<3							
55 Sodium (mg/l)	190	170	170							
56 Sodium Adsorption Ratio	3.1	2.8	2.9							
57. Sodium (%)	36	35	35							
58. Solids, Dissolved (mg/l)	1380	1240	1210							
59 Solids, Dissolved T/D	.04	.33	.23							
60. Solids, Dissolved T/Ac-Ft	1.88	1.69	1.65							
61 Solids, Suspended										
62. Strontium (ug/l)	2800	2700	2300							
63. Sulfate (mg/l)	610	510	490							
64. Sulfide (mg/l)			.2							
65. Temperature (°C)	6.0	8.0	9.0							
66. Tin (ug/l)			<20							
67. Titanium (ug/l)			<20							
68. Turbidity JTU)										
69. Vanadium (ug/l)			<15							
70. Zinc (ug/l)			10							
71. Zirconium (ug/l)			10							
72. Calcium (mg/l)	110	110	110							
73. Complete Element Span										
74. Radioactivity										
Gross Alpha (pci)	<7.8									
Radium 226*										
Gross Beta	4.5									
Thorium 230**										
Uranium**										
75. Total Organic Carbon (mg/l)	11.4	13.7	13.3							
If TOC >10 mg/liter, then										
Nitrogen (Base Extraction)										
Organic Carbon, Dissolved	11	13	13							
Organic Carbon, Suspended	.4	.7	.3							
Phenols										
Sulfur (Acid Extraction)										
76. Total Ortho-Phosphorous (mg/l										
77. Phosphate	.00	.15	.18							
78. Phosphorus, Dissolved										

Table 1.2-10

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306246
TRIBUTARY TO YELLOW CREEK EAST OF 84 MESA
YEAR 1976

	Feb. 13										
Alkalinity (mg/l)	99										
Aluminum (ug/l)	30										
Ammonia (mg/l)											
Aromatics, Polycyclic											
Arsenic (ug/l)	1										
Barium (ug/l)											
Beryllium (ug/l)											
Bicarbonate (mg/l)	121										
Bismuth (ug/l)											
Boron (ug/l)	110										
Cadmium (ug/l)											
Carbonate (mg/l)	0										
Carbon Dioxide (mg/l)											
Chloride (mg/l)	1.9										
Chromium (ug/l)											
Cobalt (ug/l)											
COD											
Coliform, Total & Fecal											
Color (PCU)	450										
Conductivity, Specific	100										
Copper (ug/l)											
Cyanide (mg/l)											
Discharge (CFS)											
Discharge, Instantaneous	8.0										
Dissolved Oxygen (mg/l)											
Fluoride (mg/l)	.1										
Gallium (ug/l)											
Germanium (ug/l)											
Hardness (Ca, Mg) (mg/l)	52										
Hardness, Non-Carbonate (mg/l)	0										
Iron (ug/l)	230										
Kjeldahl Nitrogen (mg/l)	1.1										
Lead (ug/l)											
Lithium (ug/l)											
Magnesium (mg/l)	1.7										
Manganese (ug/l)											
Mercury (ug/l)											
Molybdenum (ug/l)											
Nickel (ug/l)											
Nitrate (mg/l)											
Nitrite (mg/l)											
Nitrite Plus Nitrate (mg/l)	.34										
Nitrogen, Ammonia	.76										
Odor (Severity)											
Oil & Grease (mg/l)											
Ortho-Phosphate (mg/l)											
Ortho-Phosphorus (mg/l)	.05										
Pesticides											
pH	8.5										
Phosphorus, Total (mg/l)	2.8										
Potassium (mg/l)	1.5										
Selenium (ug/l)											
Silica (mg/l)	5.6										
Silver (ug/l)											
Sodium (mg/l)	7.3										
Sodium Adsorption Ratio	.4										
Sodium (%)	23										
Solids, Dissolved (mg/l)	104										
Solids, Dissolved T/D	2.25										
Solids, Dissolved T/Ac-Ft	.14										
Solids, Suspended											
Strontium (ug/l)	180										
Sulfate (mg/l)	5.1										
Sulfide (mg/l)											
Temperature (°C)	.5										
Tin (ug/l)											
Titanium (ug/l)											
Turbidity (JTU)											
Vanadium (ug/l)											
Zinc (ug/l)											
Zirconium (ug/l)											
Calcium (mg/l)	18										
Complete Element Span											
Radioactivity											
Gross Alpha (pci)											
Radium 226*											
Gross Beta											
Thorium 230**											
Uranium**											
Total Organic Carbon (mg/l)	82.6										
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	76										
Organic Carbon, Suspended	6.6										
Phenols											
Sulfur (Acid Extraction)											
Total Ortho-Phosphorous (mg/l)	.05										
Phosphate	8.6										
Phosphorus, Dissolved											

Table 1.2-11

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306248
UPPER BIG DUCK CREEK NORTH OF 84 MESA
YEAR 1976

	Feb. 14										
1. Alkalinity (mg/l)	107										
2. Aluminum (ug/l)	230										
3. Ammonia (mg/l)											
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4										
6. Barium (ug/l)	100										
7. Beryllium (ug/l)	<1										
8. Bicarbonate (mg/l)	131										
9. Bismuth (ug/l)	<4										
10. Boron (ug/l)	170										
11. Cadmium (ug/l)	<3										
12. Carbonate (mg/l)	0										
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	4.8										
15. Chromium (ug/l)	<3										
16. Cobalt (ug/l)	<[illegible]										
17. COD	76										
18. Coliform, Total & Fecal											
19. Color (PCU)	180										
20. Conductivity, Specific	220										
21. Copper (ug/l)	10										
22. Cyanide (mg/l)	.00										
23. Discharge (CFS)											
24. Discharge, Instantaneous	2.1										
25. Dissolved Oxygen (mg/l)											
26. Fluoride (mg/l)	1										
27. Gallium (ug/l)	<2										
28. Germanium (ug/l)	<4										
29. Hardness (Ca, Mg) (mg/l)	73										
30. Hardness, Non-Carbonate (mg/l)	0										
31. Iron (ug/l)	170										
32. Kjeldahl Nitrogen (mg/l)	3.8										
33. Lead (ug/l)	<4										
34. Lithium (ug/l)	2										
35. Magnesium (mg/l)	5.6										
36. Manganese (ug/l)	20										
37. Mercury (ug/l)	.1										
38. Molybdenum (ug/l)	5										
39. Nickel (ug/l)	<4										
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	45										
43. Nitrogen, Ammonia	.65										
44. Odor (Severity)											
45. Oil & Grease (mg/l)	2										
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.16										
48. Pesticides											
49. pH	8.3										
50. Phosphorus, Total (mg/l)	.81										
51. Potassium (mg/l)	15										
52. Selenium (ug/l)	0										
53. Silica (mg/l)	5.2										
54. Silver (ug/l)	0										
55. Sodium (mg/l)	18										
56. Sodium Adsorption Ratio	.9										
57. Sodium (%)	30										
58. Solids, Dissolved (mg/l)	149										
59. Solids, Dissolved T/D	.87										
60. Solids, Dissolved T/Ac-Ft	.20										
61. Solids, Suspended											
62. Strontium (ug/l)	220										
63. Sulfate (mg/l)	12										
64. Sulfide (mg/l)	8										
65. Temperature (°C)	.5										
66. Tin (ug/l)	<4										
67. Titanium (ug/l)	10										
68. Turbidity JTU)											
69. Vanadium (ug/l)	<4.0										
70. Zinc (ug/l)	20										
71. Zirconium (ug/l)	<8										
72. Calcium (mg/l)	20										
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pci)	28.4										
Radium 226*											
Gross Beta	33										
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)											
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved											
Organic Carbon, Suspended											
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.16										
77. Phosonate	2.5										
78. Phosphorus, Dissolved											

Table 1.2-12

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306250
LOWER BIG DUCK CREEK NORTH OF 84 MESA
YEAR 1976

	Feb. 14										
1. Alkalinity (mg/l)	135										
2. Aluminum (ug/l)	200										
3. Ammonia (mg/l)											
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	2										
6. Barium (ug/l)	100										
7. Beryllium (ug/l)											
8. Bicarbonate (mg/l)	164										
9. Bismuth (ug/l)											
10. Boron (ug/l)	130										
11. Cadmium (ug/l)	1										
12. Carbonate (mg/l)	0										
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	4.2										
15. Chromium (ug/l)	0										
16. Cobalt (ug/l)											
17. COD	87										
18. Coliform, Total & Fecal											
19. Color (PCU)	180										
20. Conductivity, Specific	320										
21. Copper (ug/l)	14										
22. Cyanide (mg/l)	.00										
23. Discharge (CFS)											
24. Discharge, Instantaneous	.68										
25. Dissolved Oxygen (mg/l)											
26. Fluoride (mg/l)	.1										
27. Gallium (ug/l)											
28. Germanium (ug/l)											
29. Hardness (Ca, Mg) (mg/l)	78										
30. Hardness, Non-Carbonate (mg/l)	0										
31. Iron (ug/l)	340										
32. Kjeldahl Nitrogen (mg/l)	3.1										
33. Lead (ug/l)	7										
34. Lithium (ug/l)	10										
35. Magnesium (mg/l)	5.6										
36. Manganese (ug/l)											
37. Mercury (ug/l)	.1										
38. Molybdenum (ug/l)											
39. Nickel (ug/l)											
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42 Nitrite Plus Nitrate (mg/l)	.52										
43. Nitrogen, Ammonia	.34										
44 Odor (Severity)											
45. Oil & Grease (mg/l)											
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.17										
48. Pesticides											
49. pH	8.7										
50. Phosphorus, Total (mg/l)	.49										
51 Potassium (mg/l)	13										
52 Selenium (ug/l)	0										
53 Silica (mg/l)	5.8										
54 Silver (ug/l)											
55 Sodium (mg/l)	25										
56 Sodium Adsorption Ratio	1.2										
57. Sodium (%)	37										
58. Solids, Dissolved (mg/l)	172										
59. Solids, Dissolved T/D	.32										
60. Solids, Dissolved T/Ac-Ft	.23										
61. Solids, Suspended											
62. Strontium (ug/l)	260										
63. Sulfate (mg/l)	11										
64. Sulfide (mg/l)											
65. Temperature (°C)	.5										
66. Tin (ug/l)											
67. Titanium (ug/l)											
68. Turbidity (JTU)											
69. Vanadium (ug/l)											
70. Zinc (ug/l)	50										
71. Zirconium (ug/l)											
72. Calcium (mg/l)	22										
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pCi)	13.6										
Radium 226*											
Gross Beta	25.0										
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)											
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved											
Organic Carbon, Suspended											
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.17										
77. Phosphate	1.5										
78. Phosphorus, Dissolved											

Table 1.2-13
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306255
YELLOW CREEK NEAR WHITE RIVER
YEAR 1976

	Jan. 28	Feb. 26	March 30								
1. Alkalinity (mg/l)	1670	1280	1530								
2. Aluminum (ug/l)	20	50	10								
3. Ammonia (mg/l)	.35	.30	0.18								
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4	6	--								
6. Barium (ug/l)			200								
7. Beryllium (ug/l)											
8. Bicarbonate (mg/l)	1460	596	1380								
9. Bismuth (ug/l)											
10. Boron (ug/l)	690	580	720								
11. Cadmium (ug/l)			1								
12. Carbonate (mg/l)	283	478	240								
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	150	130	140								
15. Chromium (ug/l)			0								
16. Cobalt (ug/l)											
17. COD			15								
18. Coliform, Total & Fecal											
19. Color (PCU)	5	20	10								
20. Conductivity, Specific	3880	2300	3700								
21. Copper (ug/l)			4								
22. Cyanide (mg/l)			0.00								
23. Discharge (CFS)											
24. Discharge, Instantaneous	2.0	3.5									
25. Dissolved Oxygen (mg/l)	12.2	10.9	11.1								
26. Fluoride (mg/l)	2.5	2.0	2.4								
27. Gallium (ug/l)											
28. Germanium (ug/l)											
29. Hardness (Ca, Mg) (mg/l)	590	550	500								
30. Hardness, Non-Carbonate (mg/l)	0	0									
31. Iron (ug/l)	20	20	--								
32. Kjeldahl Nitrogen (mg/l)	1.0	.90	--								
33. Lead (ug/l)			6								
34. Lithium (ug/l)			160								
35. Magnesium (mg/l)	120	110	100								
36. Manganese (ug/l)											
37. Mercury (ug/l)			0								
38. Molybdenum (ug/l)											
39. Nickel (ug/l)											
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	1.6	1.2	1.0								
43. Nitrogen, Ammonia	.27	.23	14								
44. Odor (Severity)											
45. Oil & Grease (mg/l)			0								
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)											
48. Pesticides											
49. pH	8.7	8.7	8.7								
50. Phosphorus, Total (mg/l)	.16	.46	.12								
51. Potassium (mg/l)	4.2	4.1	7.0								
52. Selenium (ug/l)			1								
53. Silica (mg/l)	13	14	12								
54. Silver (ug/l)											
55. Sodium (mg/l)	850	640	830								
56. Sodium Adsorption Ratio	15	12	16								
57. Sodium (%)	76	72	78								
58. Solids, Dissolved (mg/l)	2760	2240	2630								
59. Solids, Dissolved T/D	15.2	21.4	--								
60. Solids, Dissolved T/Ac-Ft	3.75	3.05	3.58								
61. Solids, Suspended											
62. Strontium (ug/l)	3100	3200	2700								
63. Sulfate (mg/l)	570	520	570								
64. Sulfide (mg/l)			0.6								
65. Temperature (°C)	0	1.0	1.0								
66. Tin (ug/l)											
67. Titanium (ug/l)											
68. Turbidity (JTU)											
69. Vanadium (ug/l)											
70. Zinc (ug/l)											
71. Zirconium (ug/l)											
72. Calcium (mg/l)	35	39	34								
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pci)											
Radium 226*											
Gross Beta											
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	13.4										
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	6.9	11	12								
Organic Carbon, Suspended		2.4	1.1								
Phenols											
Sulfur (Acid Extraction)											
76 Total Ortho-Phosphorous (mg/l)	.09	.07	.09								
77 Phosphate	.49	1.4	.37								
78. Phosphorus, Dissolved											

Table 1.2-14

PRECIPITATION SUMMARY
Inches

Recording Type Rain Gages

Gage Locations	JANUARY			FEBRUARY			MARCH			APRIL			MAY(2)		
	Maximum(1)	Total	Number of Days	Maximum(1)	Total	Number of Days	Maximum(1)	Total	Number of Days	Maximum(1)	Total	Number of Days	Maximum(1)	Total	Number of Days
Stake Springs Draw near confluence with Corral Gulch	0.05	0.13	4	0.30	0.94	7	0.77	1.63	12	0.30	0.93	11	0.32	0.86	8
Yellow Creek near White River	0.14	0.29	5	0.19	0.52	6	0.73	1.47	12	0.30	0.95	10	0.19	0.59	9
Cathedral Bluffs located in NW¼, NW¼, Sec. 14, T2S, R100W	0.15	0.40	7	0.52	1.37	7	0.60	1.14	4	0.57	1.82	8	0.28	0.94	8

Storage Type Rain Gages

(APPROXIMATE MONTHLY TOTAL, INCHES)

Gage Locations	JANUARY	FEBRUARY	MARCH	APRIL	MAY(3)
Dry Fork near west line Tract C-a	No Data	No Data	No Data	1.21	0.44
Box Elder Gulch near west line Tract C-a	No Data	No Data	No Data	0.95	0.41
Corral Gulch near west line Tract C-a	Insufficient Data	Insufficient Data	0.58	0.65	0.11

(1) Maximum precipitation for any 24 hour period
(2) Through May 24, 1976
(3) Through May 17, 1976

Table 1.2-15

ALLUVIAL HOLES
COMPARATIVE WATER DEPTHS

	December - February Depth in Feet			March - May Depth in Feet		
Hole No.	Maximum	Minimum	Quarterly Change	Maximim	Minimum	Quarterly Change
G-S S- 6			dry			dry
G-S S- 7	22.2	18.7	+ 3.5	21.3	15.2	- 2.6
G-S S- 8	38.4	37.4	- 1.0	38.3	32.6	+ 5.7
G-S S-11	44.7	44.6	- 0.1	45.3	44.2	+ 0.5
G-S S-12	34.0	33.5	+ 0.5	33.2	31.8	+ 1.4
G-S S-13			dry			dry
G-S S-14			dry			dry
G-S S-15			dry			dry
G-S S-16			dry			dry
G-S S-17			dry			dry
G-S S-18			dry			dry
G-S S-19	53.3	50.8	- 0.7	52.7	51.2	+ 0.9
G-S S-22	66.2	65.6	+ 0.6	65.6	64.9	+ 0.7
G-S S-23	29.4	28.8	+ 0.6	28.7	28.4	- 0.3
G-S S-24	6.8	6.2	- 0.6	9.1	6.8	- 2.3

*Quarterly change is the difference between the first measurement of the quarter and the last measurement made during the quarter. The signs (+ or -) designate whether the water level has risen (+) or fallen (-) from the first of the quarter to the end of the quarter.

recorded an average overall rise in water level of approximately 0.6 feet. The general increase was noted to have occurred in April and May. Alluvial holes G-S S-8, S-11, S-12, S-19, S-22 and S-23 experienced rises in water level while alluvial holes G-S S-7 and S-24 experienced lowering of water level.

The revised sampling schedule, which has been approved by the AOSS for the alluvial aquifer monitoring program, requires collecting samples for standard chemical analysis during the months of: February, April, May, June, July, August, September, and November. The revised program also requires that all samples from the alluvial holes be filtered prior to laboratory analysis. This procedure has been followed in the field by using a pressurized filtration unit. Tables 1.2-16 and 1.2-17 are summaries of the spectographic and wet chemical analysis of samples collected from the alluvial aquifer holes.

Samples were not collected at two of the holes having water in them during the last sampling period. At one of these holes, G-S S-8, a small rodent fell into the hole and was decaying there. The rodent was "fished out" and the hole was bailed out (cleaned) to remove the putrid water. The water level in G-S S-8 did not recover fast enough to allow sample collecting at that time. The other hole, G-S S-19, although wet, did not have sufficient water to allow collection of a sample.

During the quarterly reporting period measurements of specific conductance generally ranged from 1050 μmhos/cm near the western boundary of the tract to approximately 2000 μmhos/cm around the 84 Mesa. An overall increase of 100 μmhos/cm was observed in the majority of the wells. Water temperature ranged from 7.5°C at G-S S-24 to 10.5°C at G-S S-19 and S-23. The temperature generally increased from April to May 1° to 2.5°C. Measurements of pH remained between 6.0 and 6.5 with overall trends not possible to determine with reliability. Increases in water levels generally follow the seasonal increase in precipitation and snowmelt runoff. Detailed data generated from the alluvial aquifer holes are presented in the Interpretive Text portion of RBOSP Progress Report 7. Figure 1.2-2 is a sample plot of water level and conductivity. Figure 1.2-3 is a sample plot of temperature and pH.

1.2.7 Deep Aquifer Monitoring

The deep aquifer monitoring program was initiated in December 1974. The program includes the measurement of water levels and collecting water samples to determine water quality. Water samples were collected monthly from March through August 1975. Following that six month period of collecting monthly

Table 1.2-16

ALLUVIAL AQUIFER WATER ANALYSIS SUMMARY (WET CHEMICAL)

Values in mg/l

MARCH 1975 THROUGH APRIL 1976

ITEM	LOW	HIGH	AVERAGE	# ITEMS AVERAGED	STD. DEV.
Alkalinity	310.000	640.000	473.873	102	82.484
Aluminum	-0.100	1.200	0.140	10	0.375
Ammonia	-0.100	6.400	0.555	91	0.938
Arsenic	-0.010	-0.100	0.000	102	0.001
Barium	-1.000	-1.000	0.000	96	0.000
Bicarbonate	360.000	780.000	572.451	102	102.599
Boron	-0.010	27.000	1.185	102	3.078
Cadmium	-0.010	1.100	0.028	102	0.115
Calcium	28.000	240.000	104.098	102	38.128
Carbonate	-0.010	605.000	11.765	102	60.540
Chloride	1.300	71.000	17.355	102	8.418
Chromium	-0.010	0.200	0.009	101	0.038
Conductivity (umho/cm)	860.000	2275.000	1538.680	102	365.602
Copper	-0.010	8.000	0.519	102	1.223
Cyanide	-0.010	0.030	0.002	102	0.006
Dis. Solids	640.000	1670.000	1177.892	102	290.858
Fluoride	-0.100	1.200	0.367	101	0.189
Gross Alpha (pci/l)	1.400	31.000	11.992	84	6.759
Gross Beta (pci/l)	1.000	35.000	13.340	30	10.009
Hardness (total)	280.000	820.000	601.615	96	146.576
Iron	-0.050	28.000	7.148	102	5.813
Lead	0.010	13.000	0.367	101	1.290
Magnesium	3.700	150.000	84.775	102	37.254
Manganese	-0.050	27.000	3.244	102	4.643
Mercury	-0.001	-0.010	0.000	102	0.000
Nickel	0.010	0.200	0.074	96	0.057
Nitrate	-0.100	165.000	6.337	102	16.454
pH	6.000	7.200	6.464	102	0.326
Phosphate	-0.010	0.400	0.022	102	0.059
Selenium	-0.010	-0.100	0.000	102	0.000
Sil. Dioxide	22.000	44.000	31.275	102	4.397
Silver	-0.010	-0.100	0.007	95	0.013
Sodium	75.000	310.000	187.647	102	54.839
Sulfate	145.000	780.000	445.392	102	154.661
Zinc	0.010	13.000	0.711	100	1.455
Potassium	2.500	6.600	4.517	6	1.688
Lithium	-0.100	-0.100	0.000	6	0.000
DOC	2.900	292.000	51.290	90	61.795
Nitrite-N	-0.020	0.020	0.003	6	0.008
Bromide	0.100	0.900	0.717	6	0.306
C.O.D.	2.500	20.000	7.917	6	6.406
Phenols	-0.001	-0.001	0.000	6	0.000
Kjeldahl N	0.300	5.300	2.183	6	1.720

(-) Less than detectable limit given

Table 1.2-17

ALLUVIAL AQUIFERS WATER ANALYSIS SUMMARY QUALITATIVE SPECTOGRAPHIC

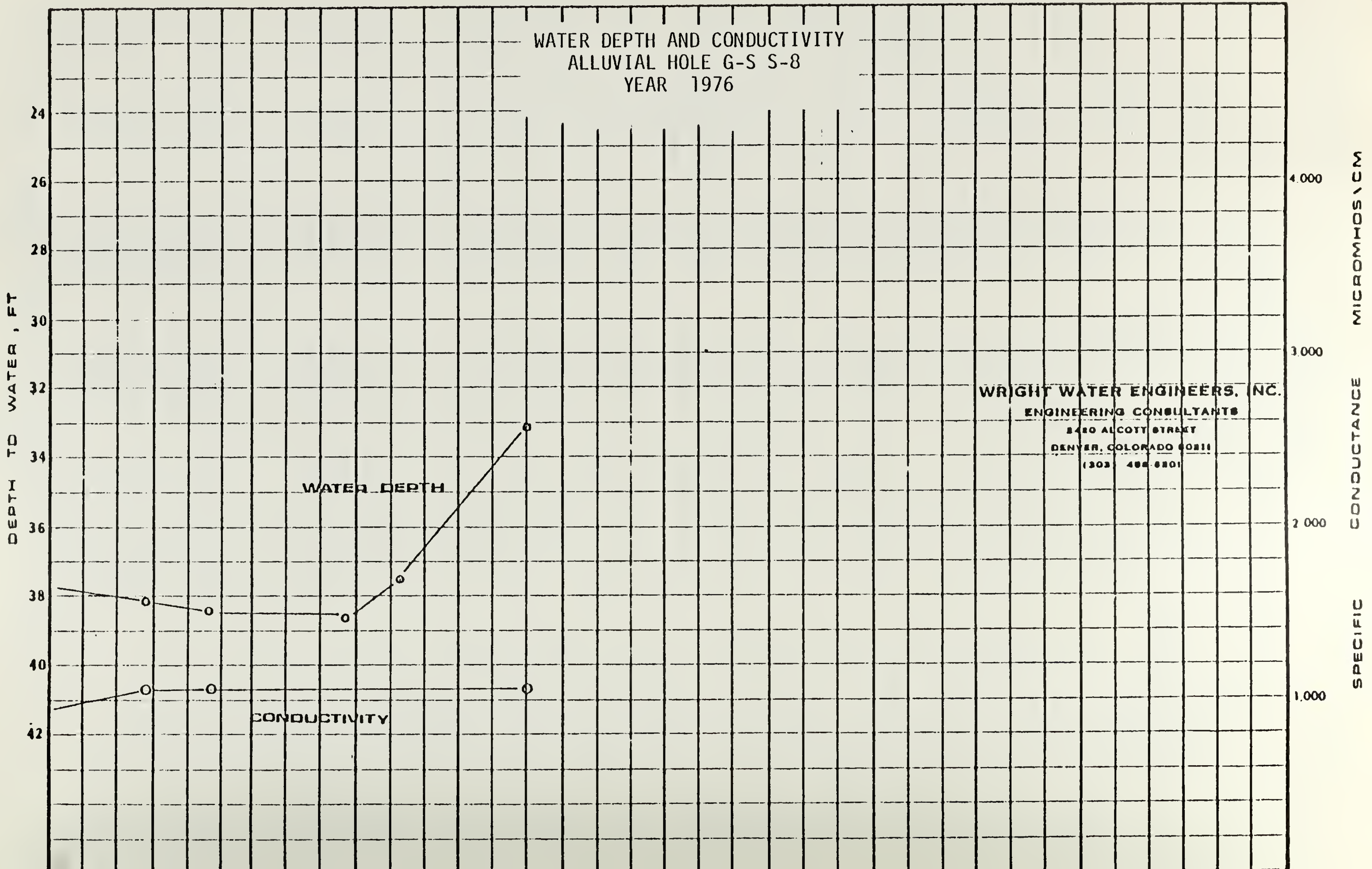
Values in mg/l

MARCH 1975 THROUGH APRIL 1976

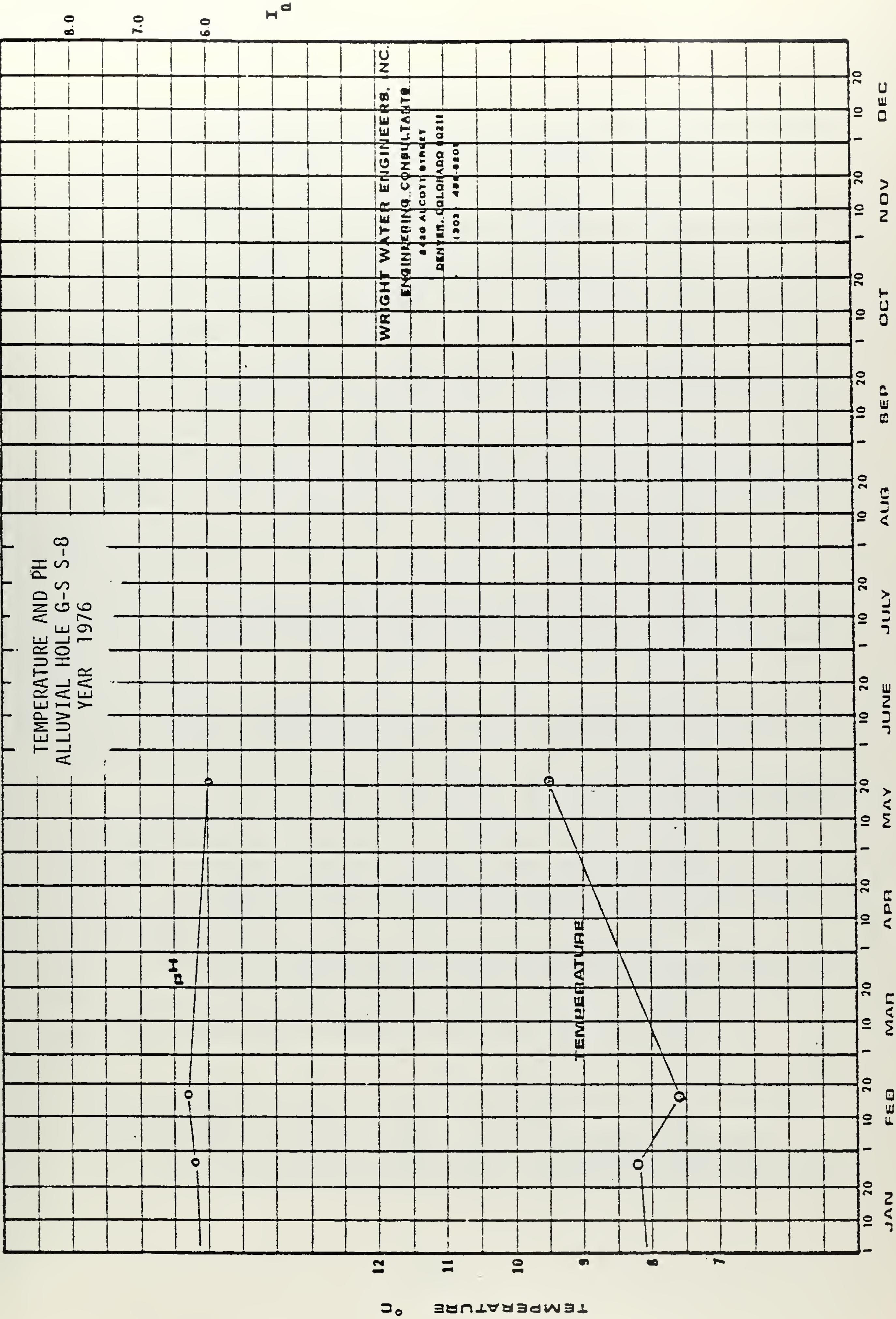
ITEM	LOW	HIGH	AVERAGE	# ITEMS AVERAGED	STD. DEV.
Aluminum	0.005	5.000	0.492	96	1.029
Antimony	---	---	---	0	---
Arsenic	---	---	---	0	---
Barium	0.001	0.050	0.008	47	0.014
Beryllium	0.001	0.001	0.001	5	0.000
Bismuth	---	---	---	0	---
Boron	0.010	0.500	0.342	96	0.183
Cadmium	---	---	---	0	---
Calcium	10.000	Major	10.000	6	0.000
Cerium	---	---	---	0	---
Cesium	0.001	0.001	0.001	1	0.000
Chromium	---	0.020	0.004	15	0.006
Cobolt	0.001	0.001	0.001	4	0.000
Columbium	---	---	---	0	---
Copper	0.001	0.050	0.014	95	0.014
Dysprosium	---	---	---	0	---
Erbium	---	---	---	0	---
Europium	---	---	---	0	---
Gadolinium	---	---	---	0	---
Gallium	0.001	0.010	0.005	5	0.005
Germanium	0.001	0.001	0.001	1	0.000
Gold	---	---	---	0	---
Hafnium	---	---	---	0	---
Holmium	---	---	---	0	---
Indium	---	---	---	0	---
Iridium	---	---	---	0	---
Iron	0.010	5.000	0.279	96	0.779
Lanthanum	---	---	---	0	---
Lead	0.001	0.200	0.028	35	0.048
Lithium	0.001	0.100	0.007	82	0.015
Lutetium	---	---	---	0	---
Magnesium	5.000	Major	2228.111	9	4405.680
Manganese	0.001	0.500	0.067	95	0.122
Mercury	---	---	---	0	---
Molybdenum	0.001	0.050	0.005	56	0.009
Neodymium	---	---	---	0	---
Nickel	0.001	0.070	0.011	7	0.026
Osmium	---	---	---	0	---
Palladium	---	---	---	0	---
Platinum	---	---	---	0	---
Potassium	0.010	2.000	0.638	96	0.480
Praseodymium	---	---	---	0	---
Radium (pci/l)	0.100	1.200	0.335	60	0.231
Rhenium	---	---	---	0	---
Rhodium	---	---	---	0	---
Rubidium	---	---	---	0	---
Ruthenium	---	---	---	0	---
Samarium	---	---	---	0	---
Scandium	---	---	---	0	---
Selenium	---	---	---	0	---
Silicon	2.000	Major	5.011	94	2.757
Silver	---	0.020	0.002	30	0.004
Sodium	1.000	Major	6.253	75	2.857
Strontium	0.010	0.100	0.096	93	0.018
Tantalum	---	---	---	0	---
Terbium	---	---	---	0	---
Thallium	---	---	---	0	---
Thorium	---	---	---	0	---
Thulium	---	---	---	0	---
Tin	0.001	0.001	0.001	12	0.000
Titanium	0.001	1.000	0.031	81	0.124
Tungsten	---	---	---	0	---
Uranium	---	---	---	0	---
Vanadium	0.001	0.020	0.008	9	0.008
Ytterbium	0.001	0.001	0.001	5	0.000
Yttrium	0.010	0.020	0.012	5	0.004
Zinc	0.001	0.020	0.005	42	0.006
Zirconium	0.010	0.010	0.010	2	0.000

--- Less than minimum detectable amount
Major - Concentration too large to quantify (see wet chemical analyses)

Figure 1.2-2



WATER DEPTH AND CONDUCTIVITY
ALLUVIAL HOLE G-S S-8
YEAR 1976



TEMPERATURE AND PH
ALLUVIAL HOLE G-S S-8
YEAR 1976

samples, sample collecting was placed on a semi-annual schedule and static water levels are measured monthly. The latest samples analyzed were collected in March 1976 and therefore will be reported in this progress report. Tables 1.2-18 and 1.2-19 are summaries of wet chemical and spectographic analyses of water samples from both the upper and lower aquifers. The analyses of the semi-annual samples collected in March 1976 are included in the summary tables. Samples from several of the holes (G-S M 4, G-S 8 and G-S 10) could not be collected due to equipment breakdown or problems associated with those specific monitor holes. Samples were not collected from the upper or lower aquifer in G-S M 4 because the sampler became lodged in the hole and attempts to free the sampler resulted in a broken cable. At the end of the quarterly reporting period plans were to correct the problem at G-S M 4 as requested by the AOSS. A water sample could not be collected in G-S 8 because something floating in the hole prevented the collection of a water sample. The problem at G-S 10 was the result of the sampler hanging up on the packer and the cable breaking causing the sampler to fall to the bottom of the hole. At the end of the reporting period plans were in progress for correcting the problems associated with these three monitoring holes. Progress Report 8 will describe the corrective procedures in detail. Table 1.2-20 and 1.2-21 are tabulations of monitor hole water levels for the upper and lower aquifers respectively. The tables reflect the using and lowering of the two aquifers.

Figure 1.2-4 is a map showing the location of the deep aquifer monitor holes. Table 1.2-22 is a drill hole summary showing the completion record of each of the holes drilled on and around Tract C-a in conjunction with the prototype oil shale leasing program.

Upper aquifer water levels are rising at about two and one-fourth feet per month near CE 708 and at only about one-third to one foot per month along the southern portion of the tract. The upper aquifer water levels along the northern portion of the tract are either stable or slightly dropping at a rate of about one-third foot per month. The relatively large rise at CE 708 appears to be associated with the snowmelt runoff and subsequent upper aquifer recharge. Upper aquifer water levels over most of the rest of the tract would appear to still be on the rise. This situation has continued since the monitor holes were completed which effectively separated the upper and lower aquifer.

The lower aquifer water levels have been dropping since the completion of the holes. Water levels dropped approximately one-half foot across the tract from March to April. From April to May water levels dropped in the lower aquifer from

Table 1.2-18

SUMMARY OF WET CHEMICAL ANALYSIS
MONITORING PROGRAM
UPPER AND LOWER AQUIFER
TRACT C-a AND VICINITY
Values in mg/l

MARCH 1975 TO MARCH 1976

Item	Lower Aquifer Low	Lower Aquifer High	Lower Aquifer Average	Lower Aquifer No. of Items Avg'd.	Lower Aquifer Std. Dev.	Upper Aquifer Low	Upper Aquifer High	Upper Aquifer Average	Upper Aquifer No. of Items Avg'd.	Upper Aquifer Std. Dev.
Alkalinity	52.000	4500.000	941.491	100	803.756	70.000	2390.000	531.546	144	452.346
Aluminum	-0.010	0.600	0.178	9	0.215	-0.010	1.000	0.144	17	0.285
Ammonia	0.020	9.600	0.724	99	1.022	-0.100	1.800	0.420	140	0.351
Arsenic	-0.010	0.030	0.000	100	0.003	-0.010	0.050	0.001	144	0.007
Barium	-0.100	-1.000	0.0	80	0.0	-0.100	-1.000	0.0	123	0.0
Bicarbonate	260.000	2980.000	1031.600	100	787.178	85.000	2760.000	615.854	144	501.377
Boron	-0.010	9.400	1.297	100	1.594	-0.010	4.800	0.659	144	0.980
Bromide	-0.020	0.400	0.033	20	0.092	-0.020	0.500	0.083	21	0.142
C.O.D.	1.300	92.000	26.505	20	23.364	0.900	400.000	82.671	21	100.460
Cadmium	-0.001	0.020	0.001	100	0.004	-0.001	0.100	0.002	144	0.009
Calcium	0.800	115.000	17.970	100	21.357	-0.010	260.000	61.037	144	55.240
Carbonate	-0.100	710.000	100.179	100	123.015	-0.100	335.000	25.883	144	49.756
Chloride	1.400	185.000	31.738	100	32.549	-1.000	87.000	16.855	144	15.280
Chromium	-0.010	-0.050	0.004	98	0.010	-0.010	0.050	0.003	143	0.010
Conductivity (umhos/cm)	845.000	5180.000	1996.230	100	1165.356	810.000	4200.000	1578.333	144	719.757
Copper	-0.010	0.300	0.022	100	0.055	-0.010	0.800	0.025	144	0.105
Cyanide	-0.010	0.030	0.001	99	0.005	-0.010	0.100	0.001	143	0.011
D.O.C.	3.000	73.000	12.090	91	8.727	1.000	50.000	10.112	127	7.250
Dissolved Solids	540.000	3640.000	1404.300	100	808.642	540.000	2850.000	1139.444	144	506.626
Fluoride	0.200	85.000	14.784	100	15.893	0.100	60.000	3.132	144	8.984
Gross Alpha (pci/l)	0.100	30.000	5.765	72	6.041	0.200	29.000	5.334	97	5.144
Gross Beta (pci/l)	3.000	830.000	49.432	37	133.239	2.000	73.000	22.464	28	18.558
Hardness (total)	20.000	690.000	185.313	80	164.773	32.000	1110.000	396.244	123	238.089
Iron	-0.050	16.200	3.350	100	3.752	-0.050	18.000	5.373	144	4.768
Lead	0.003	26.000	1.001	100	3.278	0.002	3.800	0.404	144	0.561
Lithium	-0.100	0.200	0.035	20	0.067	-0.100	0.100	0.010	21	0.030
Magnesium	1.900	130.000	31.811	100	28.387	3.500	200.000	57.758	144	36.436
Manganese	-0.050	0.800	0.099	100	0.125	-0.010	1.000	0.187	144	0.179
Mercury	-0.001	-0.010	0.000	100	0.000	-0.001	0.045	0.000	144	0.004
Nickel	-0.001	0.100	0.026	80	0.018	-0.001	0.200	0.027	123	0.027
Nitrate	-0.100	2.000	0.331	100	0.394	-0.010	7.000	0.545	144	1.008
Nitrate-N	-0.020	-0.020	0.0	20	0.0	-0.020	-0.020	0.0	21	0.0
pH	6.000	11.000	7.377	100	0.675	6.000	8.800	6.826	144	0.464
Phenols	-0.001	-0.001	0.0	20	0.0	-0.001	-0.001	0.0	21	0.0
Phosphate	-0.100	1.000	0.043	100	0.147	-0.010	1.000	0.020	144	0.100
Potassium	-1.000	3.300	1.445	20	0.898	-1.000	2.500	1.148	21	0.684
Selenium	-0.010	-0.100	0.0	100	0.0	-0.001	-0.010	0.0	144	0.0
Silicone Dioxide	-0.100	60.000	10.176	100	8.963	-0.100	58.000	26.369	144	15.740
Silver	-0.001	0.100	0.002	80	0.011	-0.001	0.100	0.006	123	0.019
Sodium	155.000	1560.000	508.900	100	378.776	32.000	1170.000	275.882	144	224.911
Sulfate	-4.000	600.000	176.540	100	148.313	-4.000	900.000	357.049	144	180.285
Sulfide	-0.100	1.600	0.530	20	0.510	0.030	40.000	3.870	22	9.715
Zinc	0.020	68.000	1.431	100	6.938	-0.010	15.000	0.792	144	1.587

(-) Less than detectable limit given.

Table 1.2-19

SUMMARY OF SPECTROGRAPHIC ANALYSIS
MONITORING PROGRAM
UPPER AND LOWER AQUIFER
TRACT C-a AND VICINITY

Values in mg/l

MARCH 1975 TO MARCH 1976

	Lower Aquifer					Upper Aquifer				
Item	Low	High	Average	No. of Items Avg'd.	Std. Dev.	Low	High	Average	No. of Items Avg'd.	Std. Dev.
Aluminum	0.001	1.000	0.065	100	0.122	0.001	1.000	0.115	144	0.190
Antimony	0.200	0.200	0.200	1	0.0	--	--	--	0	--
Arsenic	--	--	--	0	--	--	--	--	0	--
Barium	0.001	0.010	0.002	13	0.003	0.001	0.010	0.003	23	0.004
Beryllium	--	--	--	0	--	--	--	--	0	--
Bismuth	--	--	--	0	--	--	--	--	0	--
Boron	0.100	0.500	0.357	98	0.165	0.100	2.000	0.364	144	0.236
Cadmium	--	--	--	0	--	--	--	--	0	--
Calcium	0.100	Major	5.462	24	3.906	1.000	Major	7.882	17	3.533
Cerium	--	--	--	0	--	--	--	--	0	--
Cesium	--	--	--	0	--	--	--	--	0	--
Chromium	--	--	--	0	--	--	--	--	0	--
Cobalt	--	--	--	0	--	--	--	--	0	--
Columbium	--	--	--	0	--	--	--	--	0	--
Copper	0.001	0.020	0.005	91	0.005	0.001	0.020	0.006	134	0.005
Dysprosium	--	--	--	0	--	--	--	--	0	--
Erbium	--	--	--	0	--	--	--	--	0	--
Europium	--	--	--	0	--	--	--	--	0	--
Gadolinium	--	--	--	0	--	--	--	--	0	--
Gallium	--	--	--	0	--	--	--	--	0	--
Germanium	--	--	--	0	--	--	--	--	0	--
Gold	--	--	--	0	--	--	--	--	0	--
Hafnium	--	--	--	0	--	--	--	--	0	--
Holmium	--	--	--	0	--	--	--	--	0	--
Indium	--	--	--	0	--	--	--	--	0	--
Iridium	--	--	--	0	--	--	--	--	0	--
Iron	0.010	0.500	0.047	98	0.087	0.010	1.000	0.102	143	0.194
Lanthanum	--	--	--	0	--	--	--	--	0	--
Lead	0.000	0.500	0.033	29	0.097	0.001	0.200	0.020	41	0.044
Lithium	0.001	0.100	0.011	73	0.020	0.001	0.500	0.014	100	0.053
Lutecium	0.010	0.010	0.010	1	0.0	0.001	0.010	0.005	2	0.006
Magnesium	0.100	Major	3.078	23	3.236	0.100	Major	6.006	18	4.290
Manganese	0.001	0.100	0.012	83	0.023	0.001	0.200	0.019	126	0.036
Mercury	--	--	--	0	--	--	--	--	0	--
Molybdenum	0.001	0.100	0.010	50	0.018	0.001	0.500	0.018	80	0.078
Neodymium	--	--	--	0	--	--	--	--	0	--
Nickel	0.001	0.001	0.001	1	0.00	0.001	0.001	0.001	2	0.00
Osmium	--	--	--	0	--	--	--	--	0	--
Palladium	--	--	--	0	--	0.100	0.100	0.100	1	0.00
Platinum	--	--	--	0	--	--	--	--	0	--
Potassium	0.010	5.000	0.890	97	1.083	0.010	5.000	0.915	141	1.119
Praseodymium	--	--	--	0	--	--	--	--	0	--
Radium (pci/l)	0.090	0.900	0.375	24	0.258	0.100	0.800	0.200	26	0.160
Rhenium	--	--	--	0	--	--	--	--	0	--
Rhodium	--	--	--	0	--	--	--	--	0	--
Rubidium	--	--	--	0	--	--	--	--	0	--
Ruthenium	--	--	--	0	--	--	--	--	0	--
Samarium	--	--	--	0	--	--	--	--	0	--
Scandium	--	--	--	0	--	--	--	--	0	--
Selenium	--	--	--	0	--	--	--	--	0	--
Silicon	-0.500	10.000	4.310	100	2.131	1.000	20.000	5.104	144	3.756
Silver	0.000	0.001	0.001	6	0.000	0.000	0.001	0.001	13	0.000
Sodium	2.000	Major	7.346	52	2.611	2.000	Major	7.327	98	2.917
Strontium	0.001	1.000	0.097	90	0.102	0.001	1.000	0.107	134	0.094
Tantalum	--	--	--	0	--	--	--	--	0	--
Terbium	--	--	--	0	--	--	--	--	0	--
Thallium	--	--	--	0	--	--	--	--	0	--
Thorium	--	--	--	0	--	--	--	--	0	--
Thulium	--	--	--	0	--	--	--	--	0	--
Tin	0.000	0.001	0.001	2	0.001	0.001	0.001	0.001	1	0.00
Titanium	0.001	0.010	0.003	40	0.004	0.001	0.020	0.004	77	0.004
Tungsten	--	--	--	0	--	--	--	--	0	--
Uranium	-1.500	-1.500	0.0	1	0.0	--	--	--	0	--
Vanadium	--	--	--	0	--	0.001	0.001	0.001	1	0.0
Ytterbium	--	--	--	0	--	--	--	--	0	--
Yttrium	--	--	--	0	--	--	--	--	0	--
Zinc	0.001	0.200	0.012	22	0.042	0.001	0.200	0.013	44	0.036
Zirconium	--	--	--	0	--	--	--	--	0	--

-- Less than minimum detectable amount

Major - Concentration too large to quantify (see wet chemical analyses)

Table 1.2-20

UPPER AQUIFER WATER LEVELS
October 1975 - May 1976

	9 Oct.	20 Nov.	12 Dec.	28 Jan.	17 Feb.	29 Mar.	14 April	21 May
AM 2A	389.45	387.63	386.41	385.17	384.34	383.19	382.50	381.85
AM 3	33.57	33.45	33.11	33.23	33.04	32.79	31.60	30.04
CE 702	52.40	52.30	52.39	52.64	52.65	52.80	52.66	53.02
CE 707	259.79	258.76	258.11	257.25	256.64	242.22	250.32	--
CE 708	48.87	50.60	49.86	51.78	51.80	51.30	47.72	44.81
CE 709	39.84	37.02	36.14	35.90	35.69	35.50	34.88	35.00
G-S 1	244.68	245.27	245.59	246.19	246.53	246.28	244.53	243.26
G-S 2-3	103.49	102.75	102.35	102.25	101.97	100.87	100.28	99.86
G-S 4-5	75.05	74.77	74.29	74.36	74.01	73.48	72.98	72.86
G-S 6	55.62	55.54	55.42	55.50	55.45	55.27	54.95	55.22
G-S 8								
G-S 9	311.43	312.69	316.33	319.29	319.95	321.42	320.94	317.03
G-S 10	340.35	340.11	--	339.75	339.60	339.36	339.14	339.48
G-S 11	460.35	459.67	459.00	458.76	458.40	457.72	456.95	456.42
G-S 12	388.30	387.60	386.97	386.55	386.24	385.41	384.67	382.79
G-S 13	382.62	382.19	381.68	381.72	381.45	381.04	380.97	380.41
G-S 15	274.73	--	--	273.56	273.41	272.99	272.83	272.69
G-S M-1	620.64	621.13	--	619.10	618.77	618.71	625.57	619.31
G-S M-2	231.22	230.68	229.75	228.94	228.23	225.76	225.39	225.36
G-S M-3	21.59	21.96	20.32	19.16	19.21	18.57	17.50	17.72
G-S M-4	491.80	491.95	491.56	492.04	492.08	492.25	--	492.77
G-S M-5	235.73	235.81	235.24	235.70	235.64	235.51	235.38	235.75
TO-1	21.80	20.65	20.41	20.95	20.83	20.53	20.13	22.35
TO-2	113.36	113.36	122.96	112.93	112.73	112.57	112.18	113.81

-- Water levels not collected due to poor weather conditions making access to hole difficult or because problems with monitoring hole and equipment.

Table 1.2-21

LOWER AQUIFER WATER LEVELS
October 1975 - May 1976

	9 Oct.	20 Nov.	12 Dec.	28 Jan.	17 Feb.	29 Mar.	14 April	21 May
AM 2A	636.67	637.70	638.08	639.71	640.11	641.15	641.63	643.56
AM 3	310.40	311.27	311.56	313.34	313.73	314.65	315.31	316.90
CE 702	40.48	41.21	41.25	43.00	43.41	44.21	44.64	45.81
CE 707	567.51	568.70	569.21	570.67	571.04	572.19	572.53	--
CE 708	297.88	298.97	299.27	300.84	301.22	302.97	303.06	303.83
CE 709	154.31	155.55	154.92	157.62	158.63	158.87	159.60	160.82
G-S 1	602.65	602.43	602.13	602.13	601.70	601.64	601.58	601.91
G-S 2-3	254.92	255.98	256.61	258.03	258.32	259.43	259.81	261.05
G-S 4-5	98.31	99.55	100.09	100.57	101.95	102.89	103.40	104.46
G-S 6	44.06	45.88	46.26	47.72	48.12	49.01	49.45	50.65
G-S 8	649.60	650.79	651.37	651.84	651.91	651.66	651.98	651.65
G-S 9	513.25	514.31	514.68	516.10	516.22	517.19	517.96	517.56
G-S 10	389.69	380.81	--	392.76	393.06	394.01	394.57	396.13
G-S 11	721.76	723.02	723.36	725.51	725.53	726.65	727.18	727.63
G-S 12	649.79	649.76	650.08	651.97	652.30	653.36	653.92	655.54
G-S 13	573.82	574.98	575.36	577.08	577.34	578.39	578.96	580.40
G-S 15	363.99	365.27	365.64	367.28	367.64	368.71	369.24	370.79
G-S M-1	822.20	824.61	--	824.87	825.18	825.84	826.59	829.59
G-S M-2	354.96	355.03	354.44	355.14	354.69	334.60	354.73	353.64
G-S M-3	139.89	140.67	139.25	140.34	139.69	139.64	145.02	140.27
G-S M-4	562.50	563.58	563.95	565.32	565.65	566.55	--	--
TO-1	127.21	128.40	128.77	130.41	130.81	131.78	132.31	133.54
TO-2	356.68	357.83	358.31	359.62	359.95	361.01	360.93	362.93

-- Water levels not collected due to poor weather conditions making access to hole difficult or because problems with monitoring hole and equipment.

Table 1.2-22

DRILL HOLE COMPLETION SUMMARY
TRACT C-a AND VICINITY

Thirty On-Tract Holes

Drill Hole	Completion	Drill Hole	Completion
G-S 1	U&L	Am 4	P&A
G-S 2-3	U&L	CE - 701	Upper Aquifer Pumping Test
G-S 4-5*	U&L*	CE - 702	U&L
G-S 6	U&L	CE - 703	P&A
G-S 7	P&A	CE - 705-A	Upper Aquifer Pumping Test
G-S 8	Lower Aquifer Only	CE - 707	U&L
G-S 9	U&L	CE - 708	U&L
G-S 10	U&L	CE - 709	U&L
G-S 11	U&L	TO 1	U&L
G-S 12*	U&L*	TO 2	U&L
G-S 13	U&L	TO 3	Upper Aquifer Pumping Test
G-S 14	P&A	G-S D16	Lower Aquifer Pumping Test
G-S 15	U&L	G-S D17	Lower Aquifer Pumping Test
Am 2-A	U&L	G-S D18	Lower Aquifer Pumping Test
Am 3	U&L	G-S D19	Lower Aquifer Pumping Test

Four Off-Tract Holes

Drill Hole	Completion
G-S M1	U&L
G-S M2	U&L
G-S M3	U&L
G-S M4	U&L
G-S M5	AU

Totals

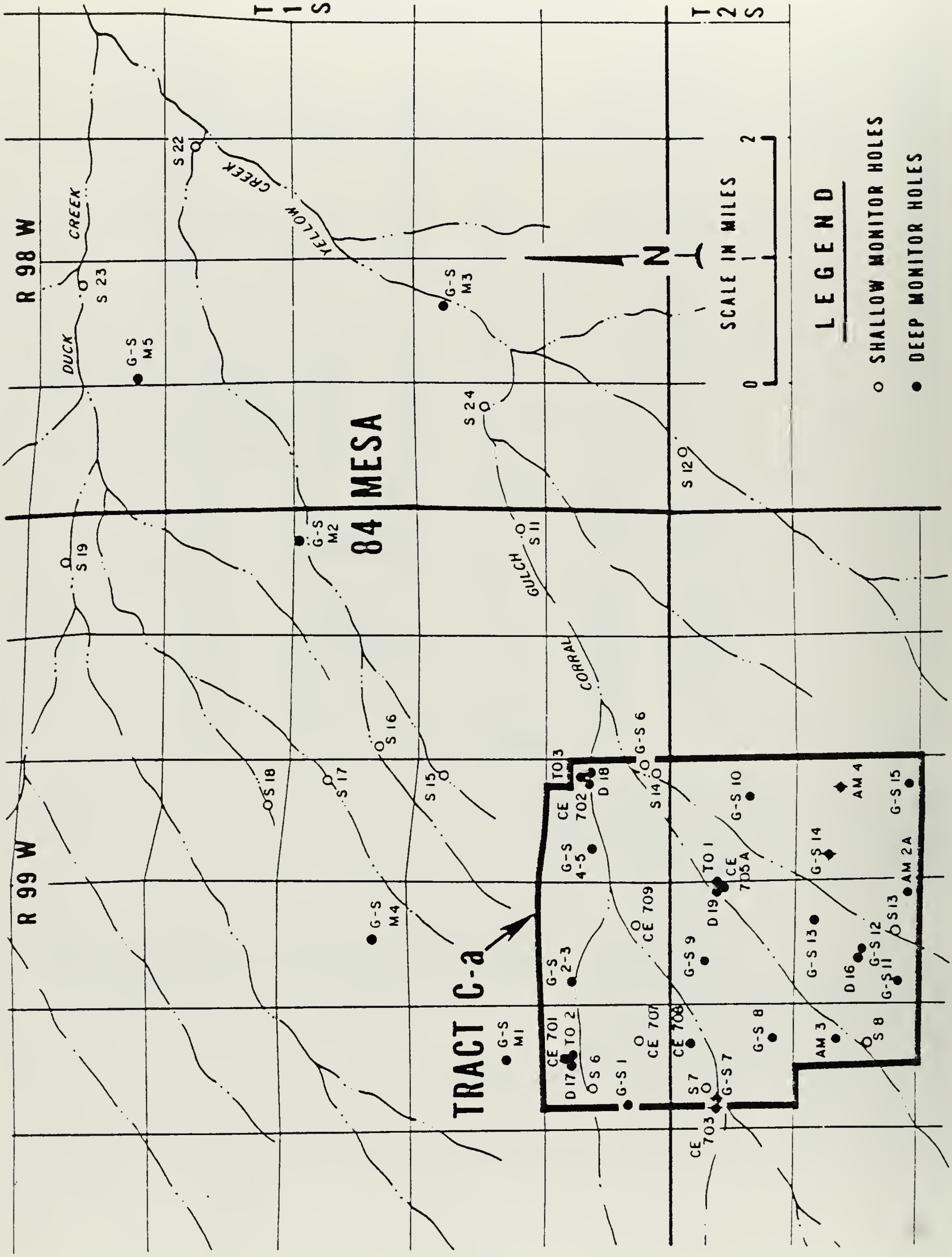
Completions in Upper and Lower Aquifers.	22
Completions in Upper Aquifer Only.	3
Completions in Lower Aquifer Only.	5
Completions in Uinta Fm. Aquifers.	1
Holes Plugged and Abandoned.	4
Total Number of Holes	35

Am = Amoco Production Company
CE = Cameron Engineers, Inc.
G-S = Gulf-Standard (Indiana)
TO = The Oil Shale Corporation
U&L = Upper and Lower Aquifer Completions
P&A = Plugged and Abandoned
AU = Aquifers, Uinta Fm.

*Holes Temporarily Modified for Upper Aquifer Pumping Test

Figure 1.2-4

LOCATION OF MONITORING HOLES



slightly over three-fourths foot to slightly over one and one-half foot.

Maps showing the piezometric level and the quarterly change in both the upper and lower aquifer are presented in the Interpretive Text portion of RBOSP Progress Report 7.

1.2.8 Hydrologic Program Summary and Analysis

Stream gaging stations monitoring perennial reaches of streams reporting flow during the quarter included: Corral Gulch east of Tract C-a, Corral Gulch south of 84 Mesa, and Yellow Creek near the White River. Six stream gaging stations monitoring intermittent streams or intermittent reaches of streams recorded three major short-duration flows during February and March. These stream gaging stations include: Box Elder Gulch near the West line of Tract C-a; "Rinky-Dink" Gulch near the east boundary of the tract; Stake Springs Draw near confluence with Corral Gulch; Tributary to Yellow Creek east of 84 Mesa; and Upper and Lower Big Duck Creek north of 84 Mesa. Apparently the flows recorded by stream gaging station monitoring intermittent reaches were caused by unseasonably high temperatures resulting in rapid snowmelt with a significant runoff. Precipitation records reviewed in relation to the runoff events do not indicate enough precipitation to have caused the flows. Some of the stream gaging stations recorded the first flow since installation during the short duration flow events.

Water quality at the stream gaging stations was slightly better than the proceeding quarter. Possible cause for this could be that additional water from melting snow is diluting the poorer quality water of the stream system. Precipitation records indicate that March and April 1976, have been the two wettest months since January 1976. Average monthly precipitation from January through late May was about 1.33 inches as indicated by the three recording rain gages. The only storage gage (located at the stream gage on Corral Gulch near the west line of Tract C-a) reporting during the entire quarterly reporting period indicated that only an average of 0.8 inches of precipitation was received monthly from January to late May 1976,

Alluvial aquifer holes which encountered water during the quarterly reporting period included: G-S S-7, G-S S-8, G-S S-11, G-S S-12, G-S S-19, G-S S-22, G-S S-23, and G-S S-24. Average measured rise in water level was slightly more than one-half foot during the quarterly reporting period. Conductivity measured in the field indicated that the trend of the values was increasing slightly and ranging from 1050 to 2000 µmhos/cm. Water temperature was trending warmer and ranged from 7.5°C to 10.5°C.

Deep aquifer monitoring indicates that water levels are rising for the upper aquifer over most of the tract. The maximum rate of rise for the upper aquifer was slightly greater than two and one-fourth foot and was measured in monitor hole CE 708. The lower aquifer water levels have been dropping. This situation (rising upper aquifer levels and dropping lower aquifer levels) is the result of the dual aquifer completion program conducted on the open holes. The completion program has effectively separated the upper and lower aquifers with a result that both of the aquifers are tending to regain the original (pre Tract C-a exploration) water level.

Connection between the upper and lower aquifers appears to be present in the northeast corner of the tract as evidenced by comparable water qualities from both the upper and lower aquifer.

Conductivity of water samples from the upper aquifer ranged from 1000 to 1400 μmhos/cm. The conductivity of the lower aquifer has decreased as the water samples collected in March 1976, were compared to those collected in July 1975. This decrease in conductivity could possibly be due to the lower aquifer recharge from the westerly direction of the tract. The lower aquifer water quality has characteristicly been of lower conductivity progressively westward across the tract.

Environmental Baseline Data Gathering Project

ABSTRACT

This report presents the progress of RBOSP environmental baseline studies during the seventh quarter of study (March, April, May 1976). Studies reported include air quality, meteorology, terrestrial and aquatic ecology, soils, archaeology and paleontology.

As in previous quarters, concentrations of most air pollutants in the study area are within low, background ranges. The two exceptions are ozone and hydrocarbons. The only parameter which exceeded standards during the quarter was nonmethane hydrocarbons (federal standards four times).

Several air quality parameters were recorded at seasonal means very close to the lower limit of detectibility for the instruments. These included: CO, H_2 and SO_2. Levels recorded for ozone and hydrocarbons appear to be background, and not associated with man's activity. Particulate levels did not exceed standards during the quarter.

Wind speeds at Sites 1 and 2 were slightly higher than at Sites 3 and 4, with a maximum mean wind speed for the quarter of 9.25 mph at Site 2. Plateau winds (Sites 1 and 2) were predominantly from the southwest. The two valley sites exhibited terrain induced channeling -- Site 3 winds were mostly westerly, Site 4 winds were mostly southwesterly.

Atmospheric stability most often fell into the slightly stable class (39% of the time). This class occurred most frequently during nighttime hours. The greatest stability occurred during early morning hours.

Upper air studies were not conducted during the quarter.

Site 4 registered the largest total precipitation during the quarter (2.76 inches) and Site 1 received the smallest amount of precipitation (1.87 inches). The maximum amount of snowfall was 8.0 inches. Maximum evaporation rate recorded for the quarter was 0.020 $g/cm^2/hr$.

Two independent visibility studies were conducted this quarter. Results of one visibility study which was conducted from Site 1 indicate a visibility range for the quarter from 3 to 150 miles. The Piceance Creek Basin study revealed that the visual range for the basin ranged between 14 and 138 miles.

Noise studies were not conducted during the quarter.

Ten different vegetation types were sampled in the study area during May. The flora identified to date includes 5 tree species, 37 shrub species, 160 forb species and 46 grass or grasslike species. One shrub, tamarisk, was added to the species list for the first time. Grazing exclosures were not sampled.

Concentrations of sediment chemicals for April 1976 were similar to concentrations in fall of 1975. Concentrations of aluminum are highest.

Sixty-five fish, representing eight species, were collected during April. The flannelmouth sucker was most abundant.

Stream velocities this April were similar to those recorded last April.

Soils studies conducted during the quarter included collection of surface soil samples from soil pits, collection of surface soils with a split spoon sampler and collection of subsurface soils with a split spoon sampler. Chemical and physical analyses are partially completed.

Depth of soil to bedrock on tract varies from 3.0 to 7.5 m. Toxic elements occur in small amounts and some soils show deficiencies in micro- and macro-nutrients.

The final report on the cultural resources of the study area was submitted during the quarter. Sites within three site clusters and one horse trap were recommended for nomination to the National Register of Historic Places.

Fragments of petrified wood and vertebrate remains were located at eight sites in the study area. These were examined by an expert paleontologist and judged to be ". . . of doubtful paleontological significance".

Browse species were sampled during the quarter to determine condition and utilization. Data are being processed.

Small mammal live trapping efforts yielded 753 individuals, representing nine species. The deer mouse was the most abundant species captured, comprising 58% of the total captures. Capture success for the seventh quarter was higher than any of the previous quarters. This reflects a 176% increase in numbers of deer mice. Removal trapping yielded 71 small mammals and pitfall trapping yielded 14. No new small mammal species were recorded during the quarter.

The maximum number of mule deer sighted during any day of aerial censusing was 790. Most deer were observed east of Tract C-a. The maximum single day count of feral horses was 115. These also occurred most often to the east of the tract. Only 13 elk were observed during a single day. Domestic cattle had been moved into the area. Approximately 930 were counted by observers as a total of all counts.

Six new bird species were encountered this quarter, bringing the total number of species spotted in the area to 138. Fifty-six species were seen during the spring quarter. One new bird species sighted, the whooping crane, is on the endangered species list.

Three species of amphibians were sighted during the breeding survey.

Invertebrate samples were collected but have not been completely processed. The data will be presented next quarter.

Special studies were conducted to determine the status of the greater sandhill crane in the study area. No cranes were sighted in the immediate vicinity during these special surveys, but some were sighted during other terrestrial studies. Sandhill cranes were observed by biologists on two occasions within the 5-mile perimeter of the study area. Two sandhill cranes were seen at Stake Springs Pond in April, and in May, four sandhill cranes and one whooping crane were seen northeast of 84 Ranch. These sightings indicate that the cranes migrate through the area and are not a part of the Colorado nesting population.

Mammalian predator and winter track count studies were not conducted during the quarter. No endangered plant species were observed.

Six of the aquatic sampling locations were dry or inaccessible during April, but flowing stations were sampled. Turbidity, specific conductance and dissolved solids were relatively high in Yellow Creek and April. This probably reflects effects of spring run-off.

Over 190 phytoplankton taxa were identified from April samples. Diatoms were most abundant.

Zooplankton data for November-December 1975, and April 1976, were reported and periphyton and benthos data for April were reported. Zooplankton were less numerous and less important as secondary consumers than benthic organisms. Periphyton are the major source of primary production.

2.0 ENVIRONMENTAL BASELINE DATA GATHERING PROJECT

Multidisciplinary environmental baseline data gathering programs have been on-going for the RBOSP since October 1974. Areas of study include air quality, meteorology, terrestrial ecology, aquatic ecology, archaeology, soils, revegetation, paleontology, trace metals and seismicity. Some parameters are monitored continuously (e.g, air quality), other parameters are monitored seasonally (e.g., small mammal studies), while other parameters are determined at regular intervals (e.g., visibility) or once or twice during the life of the project (e.g., seismicity).

Reports covering progress in each of these areas are submitted to the Area Oil Shale Supervisor on a quarterly basis. The quarter reported herein covers the period from March through May 1976. This represents the seventh quarter of study.

In most cases, objectives and methods for each of the parameters studied have been thoroughly discussed in one of the previous six progress reports. These discussions have been omitted from this report, but the numbering system for sections has been retained to facilitate comparison with previous reports. In some cases, no data were collected in a particular area during the quarter. No reference is made to these studies in the text, however, they are identified in the Table of Contents as "no data collected". Areas falling into this category include Upper Air Studies, Noise, Tracer Studies, Grazing Exclosure, Mammalian Predators, Winter Track Counts, Range Analysis, Range Production, Trace Metals and Seismicity.

Revegetation studies during the quarter were limited to the laboratory rearing of six grass species to provide voucher specimens at various ages for taxonomic purposes and continuing review of the literature. Toxicological studies are being conducted by RBOSP personnel, but are not within the scope of the environmental baseline studies and are not reported herein. Section 2.5.6 Visibility has been deleted so that all visibility studies can be discussed in Section 2.2.3.

Endangered species encountered during the quarter are discussed in Section 2.3-12. No plants in this category were observed, but one animal species (the whooping crane) was reported.

QUALITY

quality data are collected at four locations in the vicinity Tract C-a. Parameters measured and locations of stations have n described in previous progress reports. Data reported herein er the Spring 1976 quarter (March 1, 1976 through May 31, 1976).

ameters

lysis of the air quality parameters measured on Tract C-a indicates t with the exception of ozone and hydrocarbons, the mean values are the expected low background ranges. Results of the analysis are cussed and tabulated in this section.

le 2.1-1 presents a comparison of federal and state standards with surements taken from 1 March 1976 through 31 May 1976 at the RBOSP es. The only parameter which exceeded standards this quarter was methane hydrocarbon (NMHC). The number of times that these measure-ts exceeded standards was analyzed, taking into consideration Table -2 which presents the lower limits of detectability and the accuracies the analyzers used. When the lower limit of detectability of an lyzer is of similar magnitude as the regulatory standard, the lyzer will, at times, indicate higher values than the standard, though the standard may not be violated.

conclusion was reached that some of the violations of the federal methane hydrocarbon standard could have been related to instrument cifications because the combination of detection limit and accuracy similar in magnitude to the standards value. Four nonmethane rocarbon values measured for the quarter violated the federal 3-hour imum primary and secondary standards. This represents approximately percent of the available time in the quarter.

particulate concentrations observed during this quarter did not late either the federal 24-hour maximum primary and secondary ndards or the state 24-hour maximum standards. Also, the mean value all sites for the quarter, if continued at the same rate, would not ult in an annual mean higher than the federal or state annual ticulates standard.

sonal minimum, maximum, and mean values for all air quality parameters Spring 1976 are presented in Table 2.1-3.

seasonal mean values for CO, H_2S, and SO_2 shown in Table 2.1-3 similar in value to the lower limit of detectability of the analyzers. n seasonal values of nonmethane hydrocarbons and ozone are similar in nitude to the maximum levels specified by the regulatory standards. levels of these compounds appear to be background and not associated h man's activity. The hydrocarbon (both methane and total hydrocarbon) centrations remain relatively constant throughout the day, while the ne exhibits definite diurnal variations with a maximum at about n and a minimum at about midnight. Intersite comparisons between same parameters show good agreement.

Table 2.1-1 Comparison of state and federal air quality standards to measurements made during Spring 1976, RBOSP.

Parameter	Standard		Time Interval	Type of Standard	No. of Times Exceeded During Quarter	Site 1 Max. Measured Value			Site 2 Max. Measured Value			Site 3 Max. Measured Value			Site 4 Max. Measured Value		
	µg/m^3	(ppm)				µg/m^3	ppm	Time	µg/m^3	ppm	Time	µg/m^3	ppm	Time	µg/m^3	ppm	Time
CO	40,000	(35)	1 hr max.	Primary and Secondary[1]	0	1780	1.555	0200 3/16	—	—	—	1509	1.318	1200 5/21	—	—	—
CO	10,000	(9)	8 hr max.	Primary and Secondary[1]	0	1760	1.537	0300 3/16	—	—	—	1482	1.294	1400 5/21	—	—	—
Nonmethane Hydrocarbon	160	(0.24)	3 hr max. (6-9 am only)	Primary and Secondary[1]	4	78	0.119	3/4	228	0.348	3/4	46	0.070	5/9	109	0.167	3/8
NO$_2$	100	(0.05)	Annual Arith. Mean	Primary and Secondary[1]	NA	0[3]	0.000[3]	NA	—	—	—	0[3]	0.000[3]	NA	—	—	—
Ozone	160	(0.08)	1 hr max.	Primary and Secondary[1]	0	117	0.060	1800 4/9	—	—	—	131	0.067	1700 4/27	—	—	—
SO$_2$	365	(0.14)	24 hr max.	Primary[1]	0	8	0.003	1500 4/7	3	0.001	1700 4/18	23	0.009	1800 4/26	94	0.036	1500 4/6
SO$_2$	80	(0.03)	Annual Arith. Mean	Primary[1]	NA	5[3]	0.002[3]	NA	0[3]	0.000[3]	NA	13[3]	0.005[3]	NA	21[3]	0.008[3]	NA
SO$_2$	1300	(0.5)	3 hr max.	Secondary[1]	0	31	0.012	0700 4/7	8	0.003	2300 3/29	26	0.010	1900 5/1	135	0.052	1200 3/17
Particulates	260		24 hr max.	Primary[1]	0	80	NA	4/13	51	NA	4/13	130	NA	4/1	79	NA	5/19
Particulates	75		Annual Geo. Mean	Primary[1]	NA	11[4]	NA	NA	11[4]	NA	NA	11[4]	NA	NA	13[4]	NA	NA
Particulates	150		24 hr max.	Secondary[1]		80	NA	4/13	51	NA	4/13	130	NA	4/1	79	NA	5/19
Particulates	60		Annual Geo. Mean	Secondary[1]	NA	11[4]	NA	NA	11[4]	NA	NA	11[4]	NA	NA	13[4]	NA	NA
Particulates	150[5]		24 hr max.	State[2]	0	61	NA	4/13	39	NA	4/13	100	NA	4/1	61	NA	5/19
Particulates	45[5]		Annual Arith. Mean	State[2]	NA	12[3]	NA	NA	13[3]	NA	NA	14[3]	NA	NA	17[3]	NA	NA

Parameter	Manufacturer	Model	Technique	Lower Detectable Limit (ppm) 1/	Accuracy ± (ppm)
SO_2/H_2S	Bendix	8700X	Flame photometric with separation column for SO_2 and H_2S	0.005	0.020
NO_x/NO	Bendix	8101-B	Chemiluminescence	0.005	0.010
THC/CH_4	Bendix	8201	Flame ionization detector with separation column for CH_4	0.005	0.10 (THC) 0.02 (CH_4)
Photochemical Oxidant (O_3)2/	Bendix	8002	Chemiluminescence	0.001	0.004 3/
CO	Bendix	8501-5CA	Nondispersive infrared detector	0.5	0.500 3/

1/LDL is the lowest concentration that can be differentiated from instrument noise.

2/Photochemical oxidant corrected for interference due to nitrogen oxide and nitrogen dioxide as measured by the Federal Reference as ozone (O_3) with the chemiluminescence method.

3/Estimated accuracy.

Table 2.1-3. Air quality parameters, seasonal summary for Spring, 1976, RBOSP. 1/

Parameter	Units	Minimum	Maximum	Arithmetic Mean
		SITE 1		
O_3	ppm	0.018	0.060	0.040
CO	ppm	0.000	1.555	0.432
NO	ppm	0.001	0.092	0.011
NO_x	ppm	0.000	0.075	0.009
CH_4	ppm	1.005	1.635	1.357
THC	ppm	1.048	1.871	1.387
H_2S	ppm	0.001	0.028	0.001
SO_2	ppm	0.001	0.027	0.002
Particulates	$\mu g/m^3$	1	80	11 2/
		SITE 2		
CH_4	ppm	1.117	1.502	1.302
THC	ppm	1.250	2.251	1.446
H_2S	ppm	0.001	0.009	0.002
SO_2	ppm	0.000	0.008	0.000
Particulates	$\mu g/m^3$	1	51	11 2/
		SITE 3		
O_3	ppm	0.002	0.067	0.034
CO	ppm	0.178	1.318	0.585
NO	ppm	0.000	0.103	0.013
NO_x	ppm	0.000	0.099	0.013
CH_4	ppm	0.755	1.583	1.389
THC	ppm	0.740	1.589	1.407
H_2S	ppm	0.000	0.012	0.004
SO_2	ppm	0.000	0.014	0.005
Particulates	$\mu g/m^3$	1	130	11 2/
		SITE 4		
CH_4	ppm	0.946	1.661	1.351
THC	ppm	0.994	1.869	1.400
H_2S	ppm	0.001	0.052	0.007
SO_2	ppm	0.002	0.095	0.008
Particulates	g/m^3	3	79	13 2/

1/ Values presented are based upon hourly averages

2/ Geometric mean

Table 2.1-4 gives the particulate concentration for the quarter for each site. The frequency of sampling at Sites 1 and 3 was increased during this quarter to further define particulate concentrations. The large variation between samples and sites is expected. Considerable fugitive dust is more than likely due to activities on the tract. For example, Site 3 is not far from a well-traveled road, which may be the source of the relatively higher values obtained there.

Particle size data by concentration and particle size range are given in Table 2.1-5. These data show that a large portion of the particulate weight is made up of particles of 0 to 0.95 μm. The values indicated by less than 1 $\mu g/m^3$ are less than the estimated concentration measurable by the data collection technique.

The results of particle trace element analysis on a particulate sample taken over one 24 hour period during the quarter are given in Table 2.1-6.

Table 2.1-4. Particulate concentration data for Spring 1976; values are presented in µg/m^3, RBOSP.

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
March	2	1976	1	7	19	4
	5		12 1/	5	3	4
	8		6	5	8	4
	11		15	12	15	10
	14		8	5	7	3
	17		10 2/	4	4	5
	20		15 1/	10	7	8
	23		16	14	20	27
	26		3	3	1	3
	29		4 1/	1	4	3
April	1		32	19	130	43
	4		21	14	20	18
	7		4	4	7	6
	10		29 3/	16	24	15
	13		80	51	54	49
	16		10	7	7	8
	18		6		4	
	19			3		4
	20		13		10	
	22		31	33	33	45
	24 1/		3		6	
	25			51		73
	26 1/		19		7	
	28		11	16	18	28
	30		10		28	
May	1			17		13
	2 1/		8		18	
	4		65	48	50	68
	6		39		9	
	7			9		11
	8 1/		1		3	
	10		10	8	16	12
	12		19		18	
	13			31		25
	14 1/		9		13	
	16		8	13	10	9
	18		14		7	
	19			34		79
	20 1/		11		22	
	22		7	5	7	9
	24		13		12	
	25			40		12
	26 1/		17		15	
	28		23	22	23	50
	30		18		15	
	31			19		26

Table 2.1-4. Continued.

1/ Total particulate concentration from the particulate sizing measurement.
2/ Sample date was 3/18/76
3/ Sample date was 4/9/76.

Table 2.1-5. Particulate concentration by equivalent aerodynamic diameter[1/] at Site 1 for Spring, 1976, RBOSP.

Size Range (microns)	3/5	3/20	3/29	4/9	4/24	5/2	5/14	5/26
7.2 - ∞	<1	3	<1	2	<1	1	1	2
3.0 - 7.2	<1	3	<1	3	<1	<1	1	3
1.5 - 3.0	<1	3	<1	3	<1	<1	<1	1
0.95 - 1.5	2	2	<1	2	<1	<1	<1	1
0 - 0.95	10	4	4	19	3	7	7	10

[1/] "Equivalent Aerodynamic Diameter" is defined as the size of a spherical particle of density 1 gm/cc, which has the same terminal settling velocity as the sampled particle.

Uranium	<0.1	Terbium	<0.1	Ruthenium	<0.1	Vanadium	2.0
Thorium	<0.1	Gadolinium	<0.1	Molybdenum	0.18	Titanium	49
Bismuth	0.25	Europium	<0.1	Niobium	0.13	Scandium	<0.1
Lead	4.1	Samarium	<0.1	Zirconium	0.63	Calcium	≈ 1300
Thallium	<0.1	Neodymium	0.50	Yttrium	0.20	Potassium	≈ 1200
Mercury	<0.0	Praseodymium	0.16	Strontium	15	Chlorine	7.5
Gold	<0.1	Cerium	0.51	Rubidium	1.7	Sulphur	64
Platinum	<0.1	Lanthanium	0.21	Bromine	0.19	Phosphorus	140
Iridium	<0.1	Barium	11	Selenium	0.10	Silicon	≈10000
Osmium	<0.1	Cesium	<0.1	Arsenic	0.60	Aluminum	≈ 1800
Rhenium	Internal Standard	Iodine	0.10	Germanium	<0.1	Magnesium	510
Tungsten	<0.1	Tellurium	<0.1	Gallium	<0.1	Sodium	200
Tantalum	<0.1	Antimony	*	Zinc	30	Fluorine	36
Hafnium	<0.1	Tin	1.0	Copper	130	Oxygen	NR
		Indium	Internal Standard				
Lutecium	<0.1			Nickel	0.43	Nitrogen	NR
Ytterbium	<0.1	Cadmium	0.15	Cobalt	0.11	Carbon	NR
Thullium	<0.1	Silver	0.12	Iron	710	Boron	NR
Erbium	<0.1	Palladium	<0.1	Manganese	11	Beryllium	<0.1
Holmium	<0.1	Rhodium	<0.1	Chromium	4.1	Lithium	9.4
Dysprosium	<0.1						

1/ Samples are collected on cellulose filters and analyzed by spark source mass spectrometry. For conversion to ng/m^3 multiply values by 0.265.

NR - Not Reported
* - Blank Level Higher than Sample

ETEOROLOGY

eteorological parameters measured and locations of sites are given n previous progress reports. Upper air studies are scheduled to be one for 5 quarters of the baseline program. An upper air study was ot executed during the 7th quarter. Tracer diffusion studies are cheduled to be conducted later this year. Ambient noise level easurements have been completed for the first baseline monitoring ear.

he baseline meteorological program is established at two lower tmospheric levels, referred to in this report as lower air studies nd upper air studies. The lower air studies include data obtained rom the four station network; the upper air studies involve obtaining ata on the winds aloft and vertical temperature profiles. Upper ir studies are performed on a seasonal basis. Tracer studies are erformed during the baseline study period concurrently with upper air easurements. Studies which provide useful information, but do not all into these categories are: precipitation, evaporation, solar adiation, noise, snowcourse, and visibility (discussed under iscellaneous, Section 2.2.3).

he Spring 1976 quarter (season), as used in this section is defined s March 1, 1976 through May 31, 1976.

ower Air Studies

he 1976 spring season summaries of the minimum, maximum, and mean alues of the meteorological parameters measured at each site are resented in Table 2.2-1. The composite hour, as illustrated in igures 2.2-1 through 2.2-6, is the mean of the data taken during a articular hour of the day for all days of the period indicated. composite day defines the minimum, maximum, and mean values for 4 composite hours of a month. The minimum and maximum listed are he individual hourly averages which are greater than or less than ll other hourly averages.

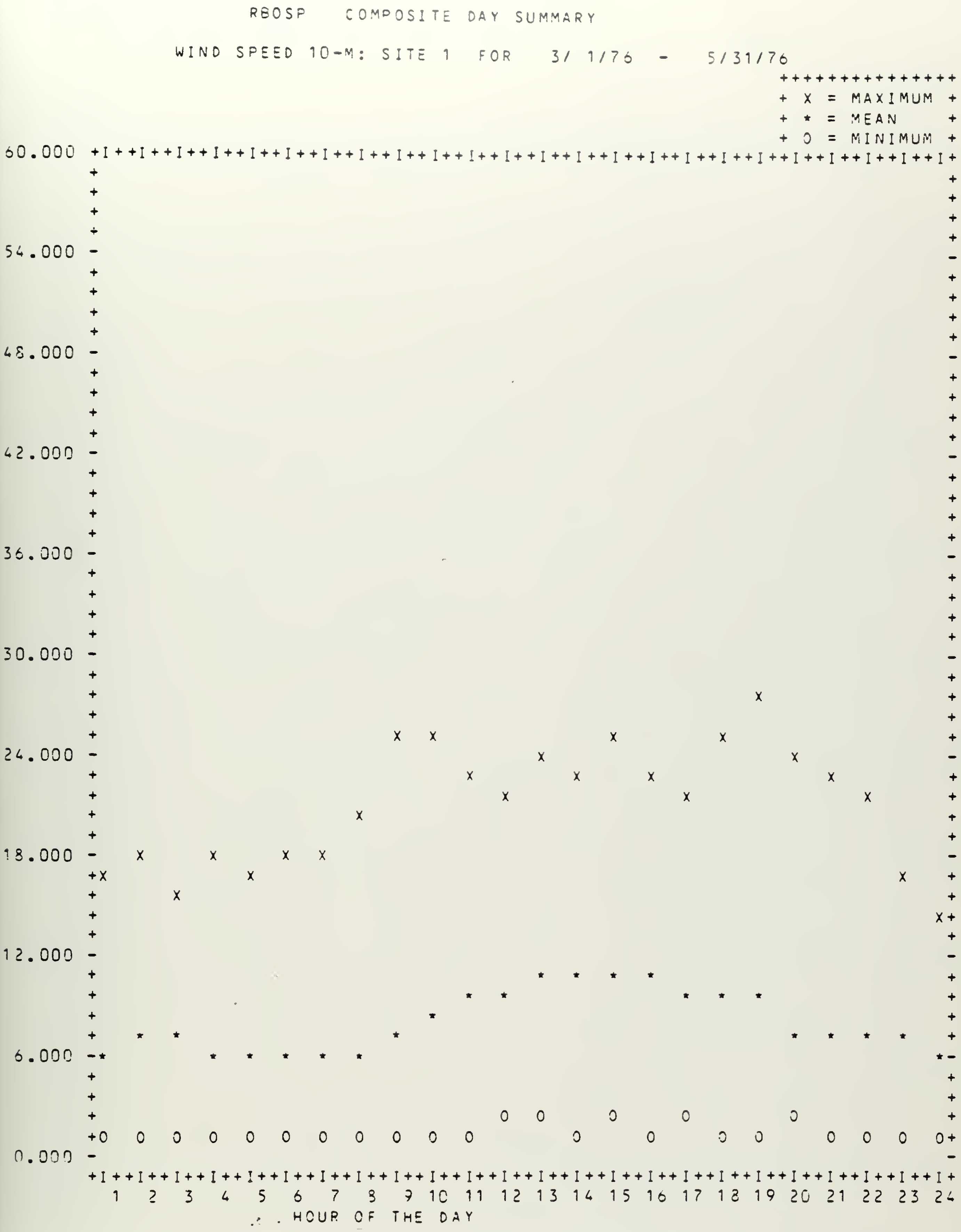
ind at Sites 1 and 2 (10-m level) were predominantly from the outhwest during Spring 1976. The mean wind speeds were 7.94 and .25 mph, respectively. Although Sites 1 and 2 are at about the ame elevation (7,400 feet above MSL), the local terrain at Site 2 is elatively flatter than at Site 1. The Site 2 monitoring location is he highest point within a radius of approximately 1 km. The 10-m evel of the main meteorological tower at Site 1 is approximately 50 m ower than the elevation of several knolls within several hundred eters. The increased terrain influence at Site 1 is probably responsible or the lower mean wind speed.

ean wind speeds at Sites 3 and 4 for the Spring 1976 period were .02 and 6.33 mph, respectively. Sites 3 and 4, below plateau levels, re situated in the approximate centers of Corral Gulch and Yellow reek Gulch at elevations of 6,570 and 6,280 feet above MSL. Corral ulch is oriented in a west to east direction. Yellow Creek Gulch is riented in a south-southwest to north-northwest direction.

Table 2.2-1. Meteorological parameters, seasonal summary for Spring 1976, RBOSP.[1/]

Parameter	Units	Minimum	Maximum	Mean
SITE 1				
Wind Speed (10 m)	mph	0.62	27.30	7.94
Wind Speed (30 m)	mph	0.60	32.51	10.10
Wind Speed (60 m)	mph	0.67	56.61	11.82
Wind Direction Sigma (10 m)	degrees	1.42	33.31	12.17
Air Temperature (10 m)	C	-14.20	22.91	4.84
Air Temperature (30 m)	C	-14.70	22.19	4.56
Temperature Difference (60 to 10 m)	C	-2.71	6.05	0.18
Relative Humidity (10 m)	%	16.16	91.52	36.37
SITE 2				
Wind Speed (10 m)	mph	0.60	33.89	9.25
Air Temperature (10 m)	C	-15.50	21.97	4.27
SITE 3				
Wind Speed (10 m)	mph	0.64	26.42	8.02
Air Temperature (10 m)	C	-20.50	25.19	4.16
SITE 4				
Wind Speed (10 m)	mph	0.54	28.39	6.33
Air Temperature (10 m)	C	-27.10	26.62	4.43

[1/] Values presented are based upon hourly averages.


RBOSP COMPOSITE DAY SUMMARY

WIND SPEED 10-M: SITE 1 FOR 3/ 1/76 - 5/31/76

Figure 2.2-1. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

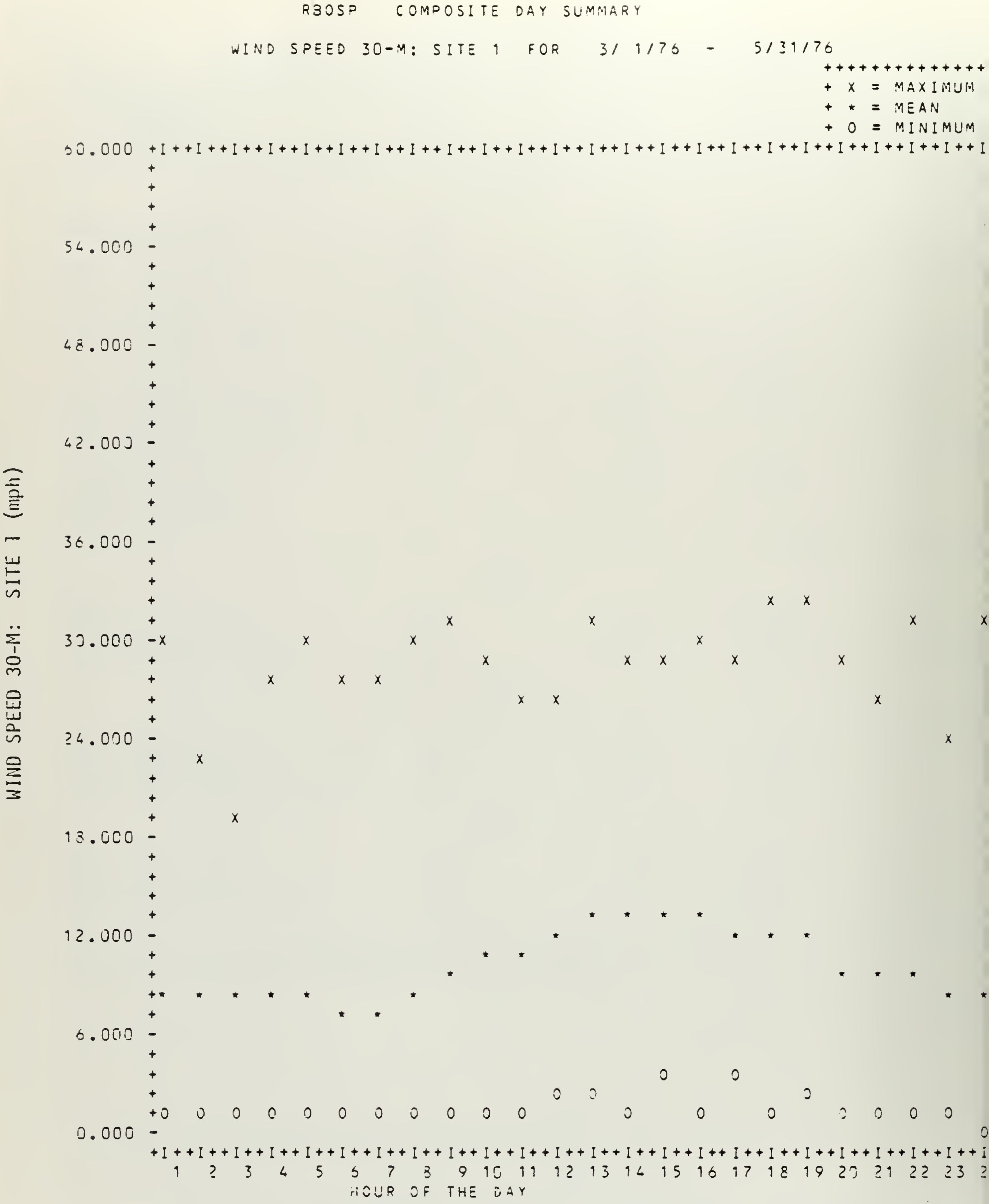


Figure 2.2-2. Wind speed, 30-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

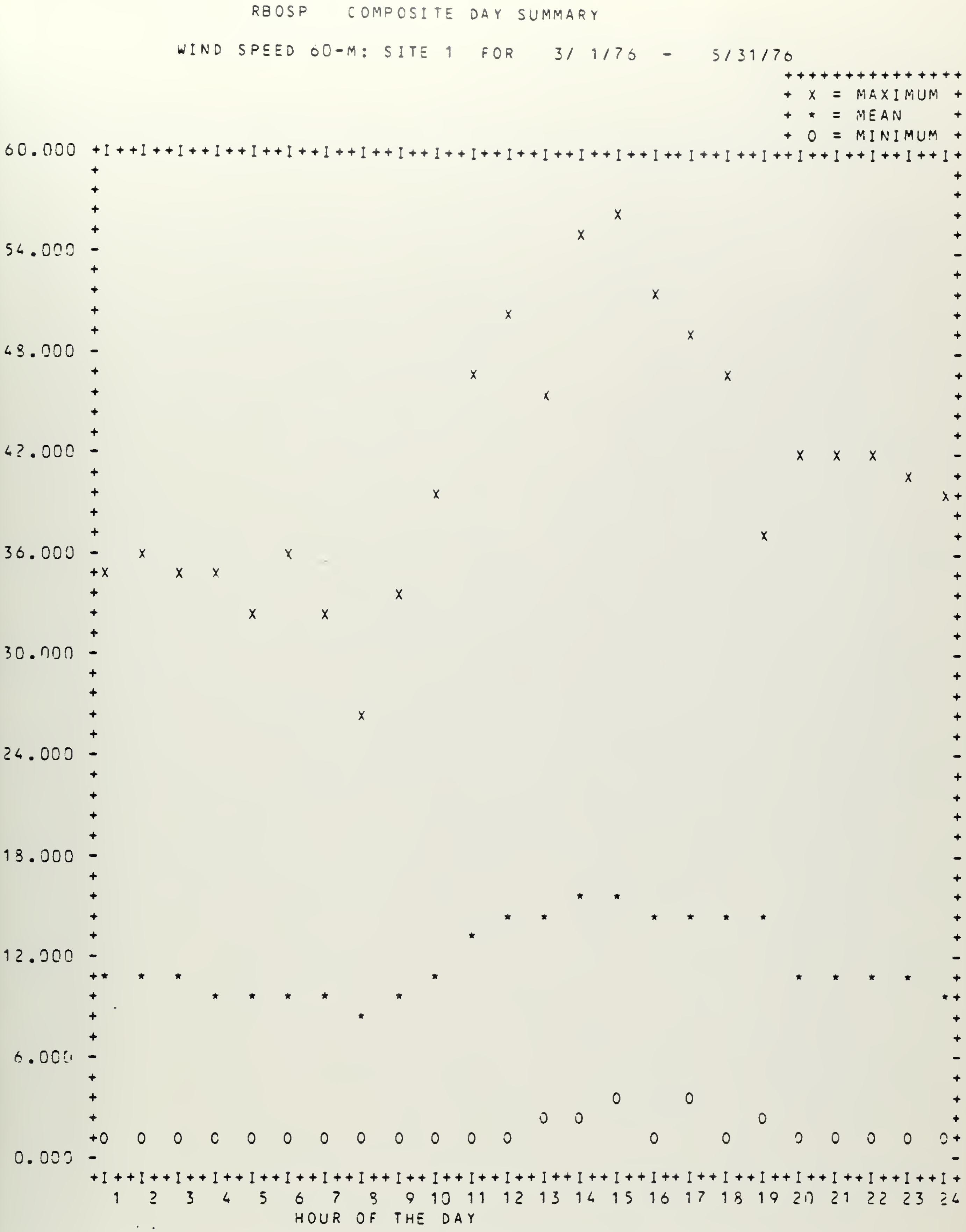


Figure 2.2-3. Wind speed, 60-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

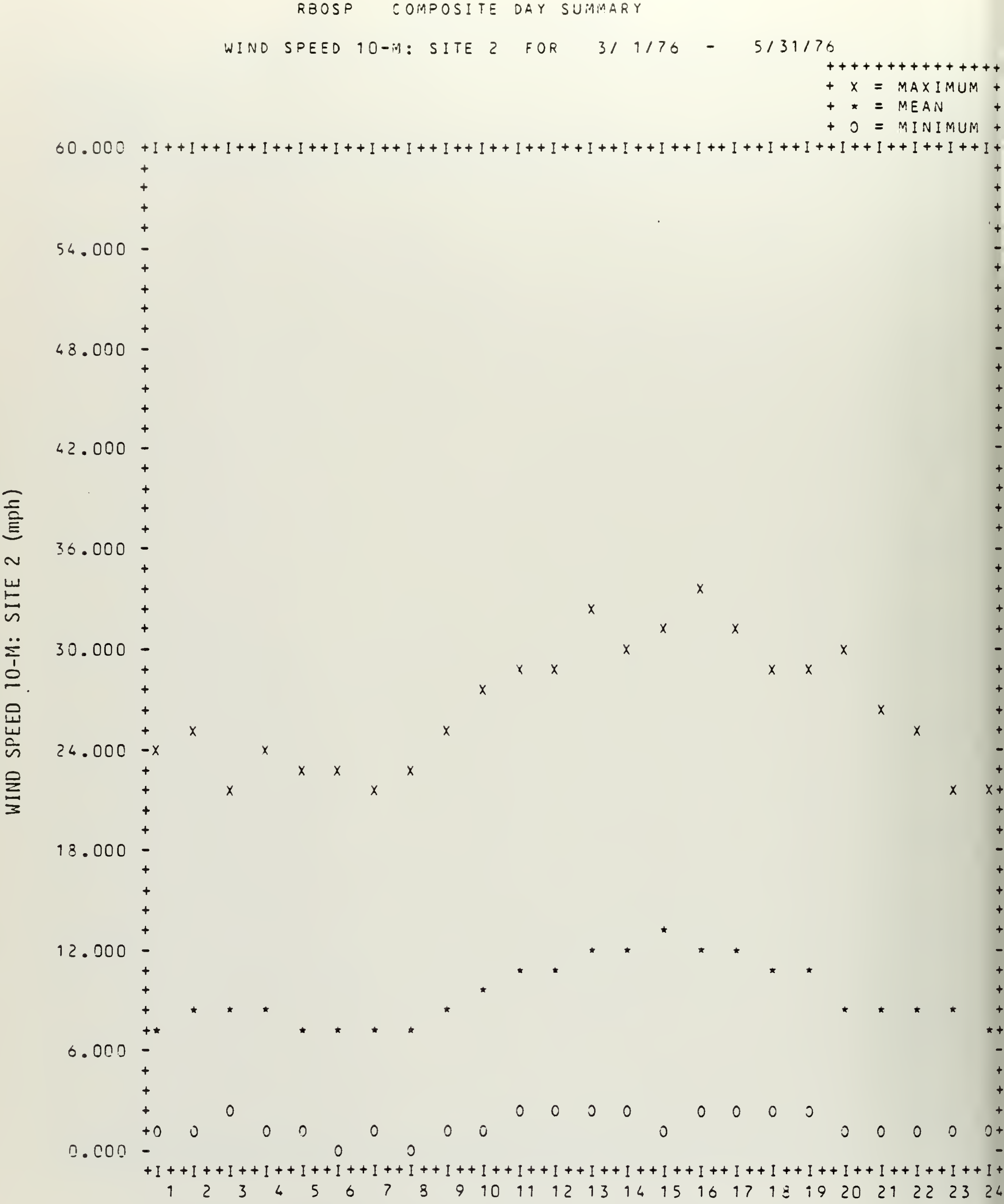
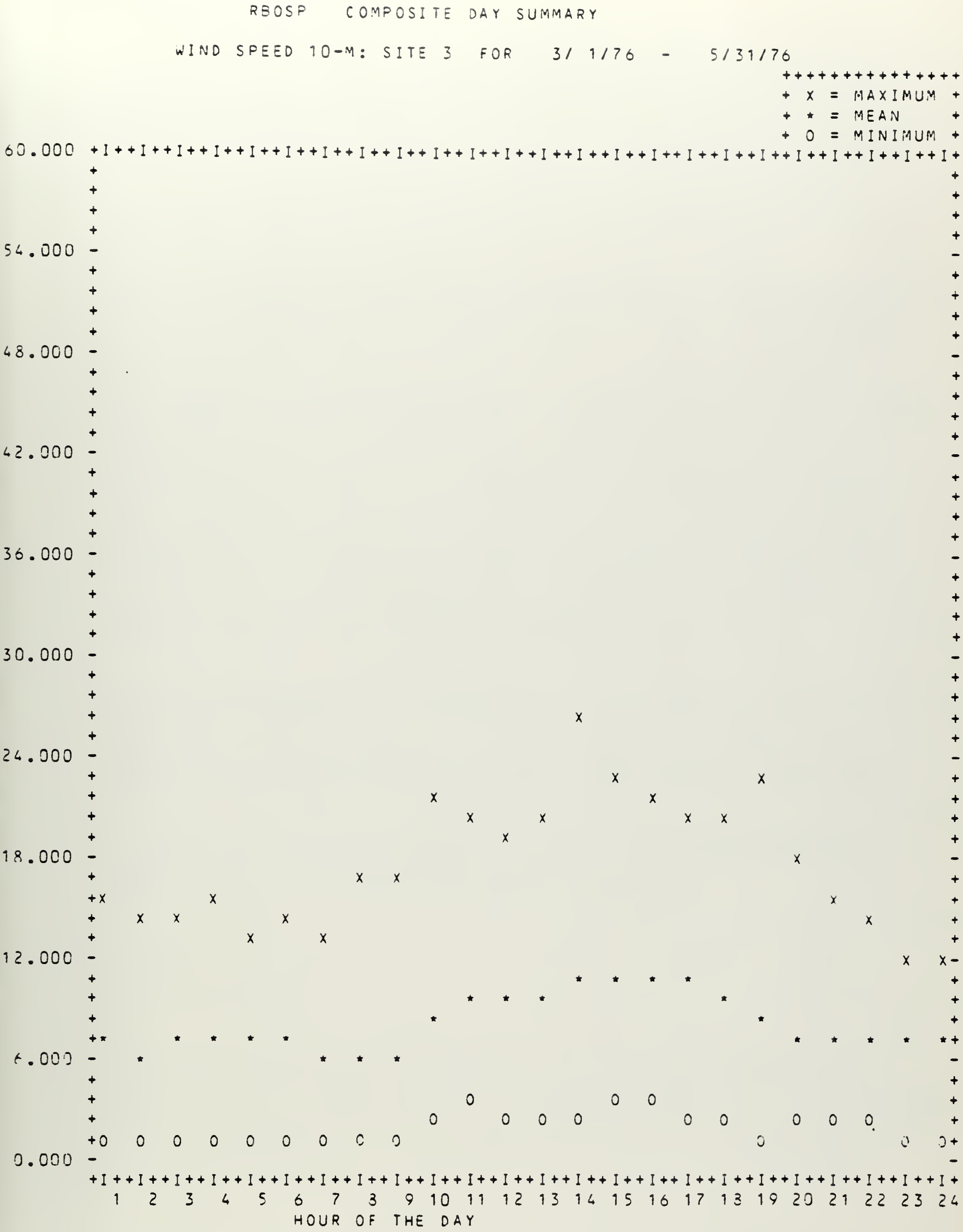


Figure 2.2-4. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 2, RBOSP.



RBOSP COMPOSITE DAY SUMMARY

WIND SPEED 10-M: SITE 3 FOR 3/ 1/76 - 5/31/76

Figure 2.2-5. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 3, RBOSP.

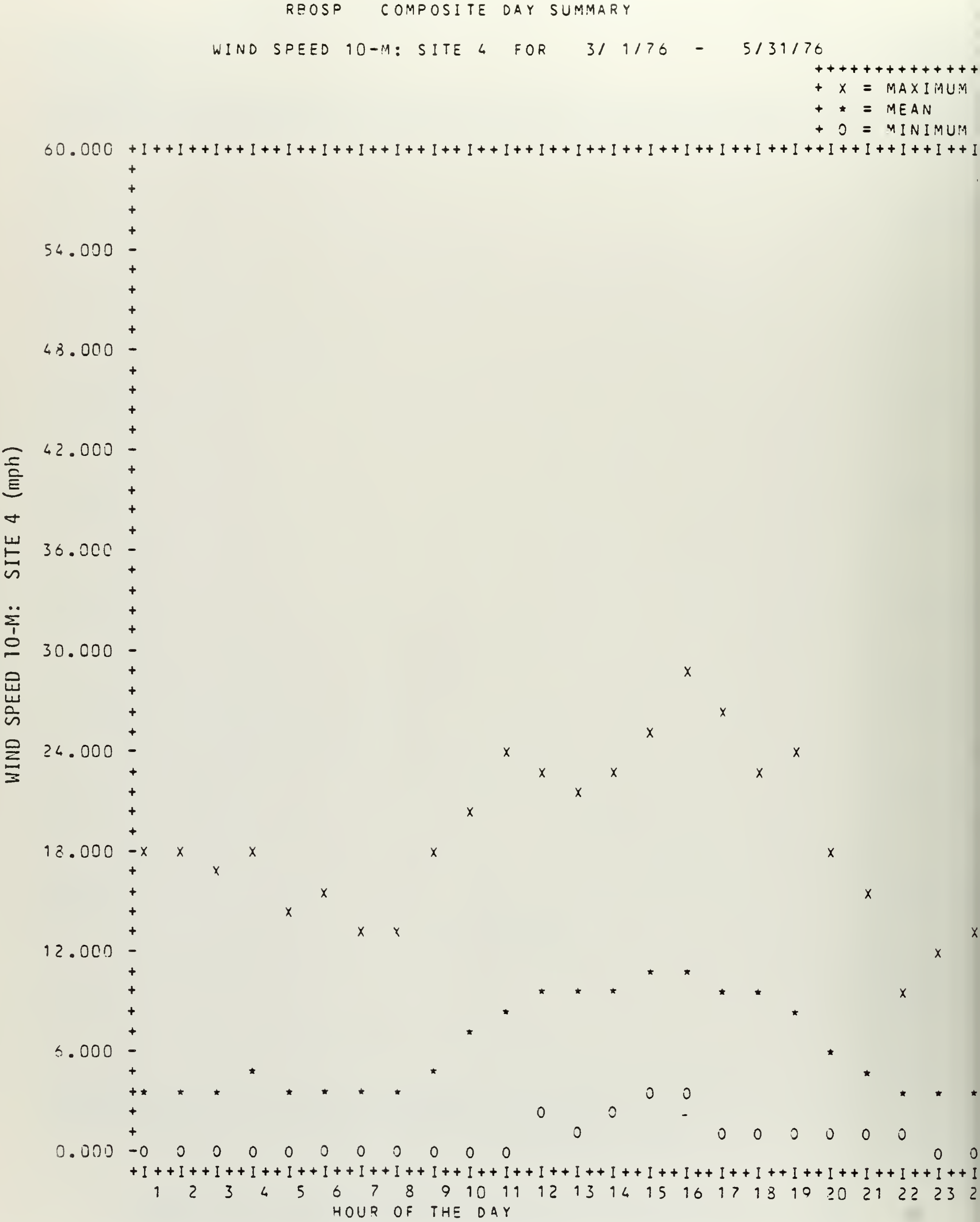


Figure 2.2-6. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 4, RBOSP.

The diurnal variation of mean wind speed for each site is shown in Figures 2.2-1 to 2.2-6. Mean wind speeds average 4 to 6 mph higher during daytime hours than nighttime hours with Site 1 showing the smaller variation. The 60-m level has about a 4 mph higher wind speed during the day than at night. During this quarter there was a single peak for the 60-m level mean wind speed, at about 1500 hours.

The diurnal variation of the wind direction sigma at the 10-m level at Site 1 is shown in Figure 2.2-7.

Wind rose data for Spring 1976 are presented for all four monitoring stations in Figure 2.2-8. The percent of occurrence of each wind class can be obtained from the number scale on each wind rose plot.

Wind rose data (10-m level) from Sites 1 and 2 are comparable. The reduced frequency of occurrence of southwest winds relative to south-southwest and west-southwest winds is probably caused by the influence from a small knoll about 200-m southwest of Site 1. Extreme terrain-induced wind channeling effects exist at Sites 3 and 4. Winds at Site 3 are predominantly from the west, which is in agreement with the westerly course of Corral Gulch. The predominant winds at Site 4 are from the southwest, corresponding closely to the orientation of Stake Springs Draw and Yellow Creek. In addition to the terrain-induced channeling of the gradient winds at Sites 3 and 4, valley drainage flows contribute significantly to the direction of winds.

The term gradient wind is used here to describe wind flows resulting from a pressure difference between two points at the same elevation. While the term valley drainage flow is used to describe the winds resulting from radiative cooling of the near surface layers of air which produces a subsiding, down-slope flow.

A least squares fit to the mean seasonal wind speed as a function of height at the 60-m tower (Site 1) was done to investigate the applicability of the logarithmic wind profiles:

$$\bar{u} = \frac{u^*}{K} \ln \left(\frac{Z}{Z_O}\right)$$

where Z_O is the roughness parameter, K is the von Karman constant, and u^* is the friction velocity. The seasonal data fit the logarithmic wind profile to a high degree of confidence (coefficient of determination = r^2 = 0.996) with u^*/K = 2.15 mph and Z_O = 25 cm, Z = height above ground (in meters).

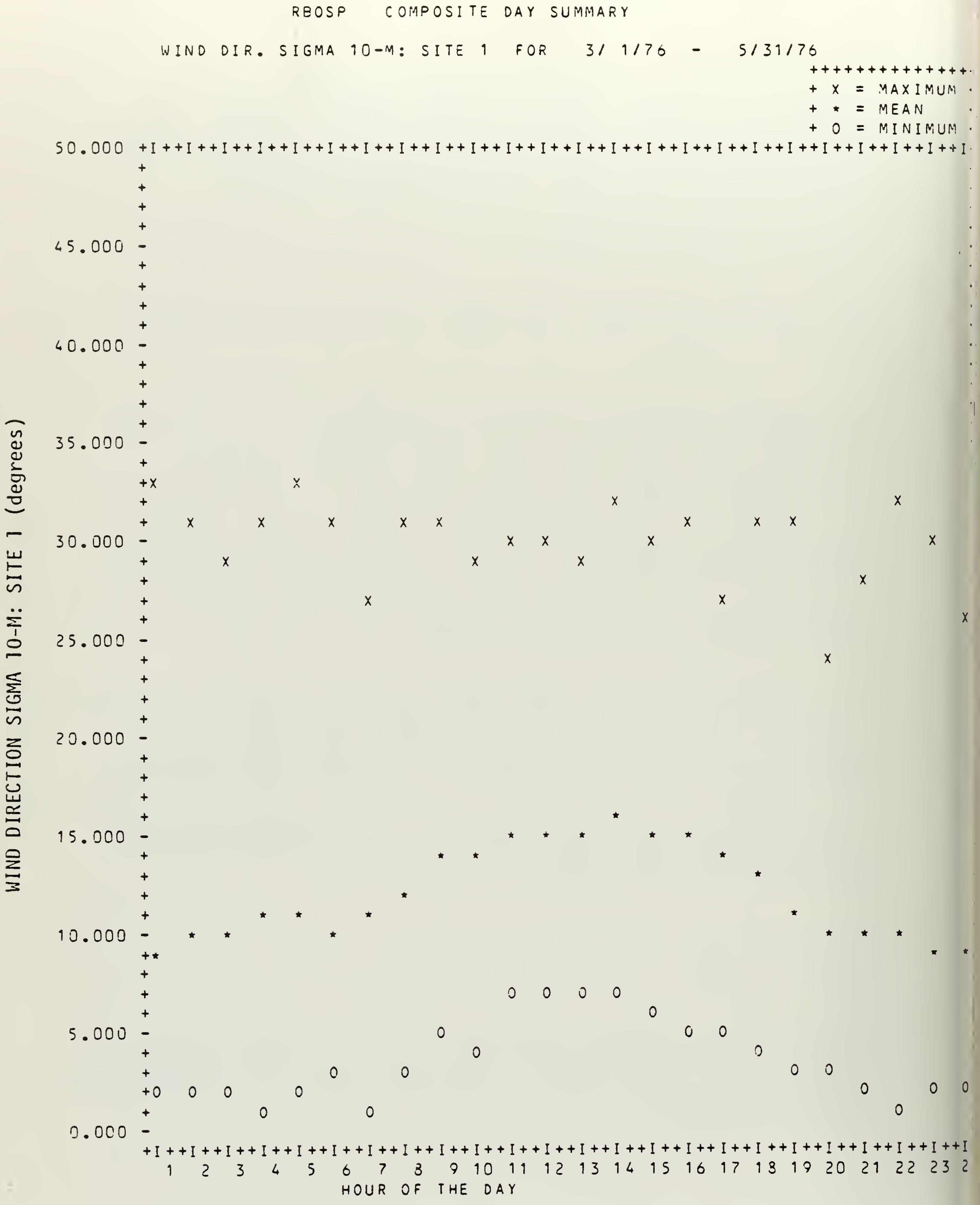


Figure 2.2-7. Wind direction sigma, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

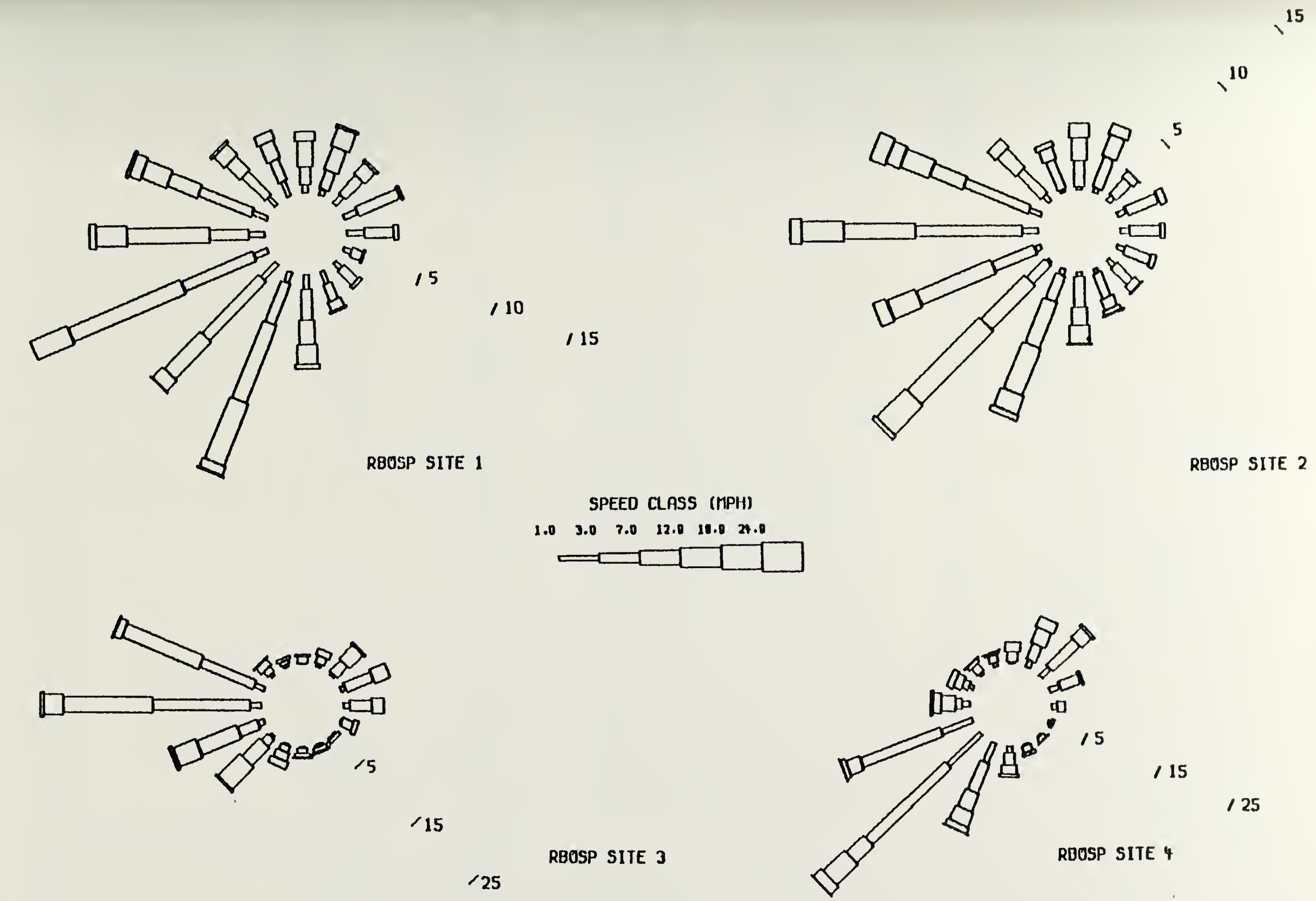


Figure 2.2-8. Wind roses for the 10-m level for Spring 1976 at Sites 1, 2, 3, and 4, RBOSP.

The minimum, maximum, and mean values of air temperature for each of the four sites and temperature difference at Site 1 as a function of the hour of the day for Spring 1976, are plotted in Figures 2.2-9 through 2.2-14.

The valley sites (3 and 4) have a much larger diurnal temperature variation than the plateau sites (1 and 2). The intensity of the cold portion of the composite days at Sites 3 and 4, in relation to that at Sites 1 and 2, is much greater. This is the result of valley drainage flows of cold air. The composite day air temperature data for Sites 3 and 4 indicate that colder air accumulates at Site 4. The elevation difference (200 ft) and the Stake Spring Draw air flow, as well as the Corral Gulch air flow draining into the Yellow Creek Gulch, contribute to this intensity difference.

Although there is a difference in the diurnal variation among all sites, the average temperatures over the season agree well between sites.

Atmospheric stability conditions were determined from temperature difference measurements made between the 10-m and the 60-m level on the main meteorological tower at Site 1. Figure 2.2-14 presents the minimum, maximum, and mean composite day temperature differences as a function of the time of day for Spring 1976. The data indicate that the mean surface inversion is relatively weak (about a -0.1 to -0.4 C difference in temperature) during the interval from 2100 hours MST in the evening until 0700 hours MST the following morning. When the break-up of the mean surface inversion occurs, temperature difference values become significantly unstable. The intensities of the most stable inversions are greater than those of the most unstable conditions.

The percentage of occurrence of the modified Pasquill stability categorie for Spring 1976 and the associated mean wind speeds are presented in Tabl 2.2-2. Stability categories were calculated according to the following criteria:

Stability Index	Temperature change (C) with heights per 100 m
A	$\Delta T < -1.9$
B	$-1.9 \leq \Delta T < -1.7$
C	$-1.7 \leq \Delta T < -1.5$
D	$-1.5 \leq \Delta T < -0.5$
E	$-0.5 \leq \Delta T < 1.5$
F	$1.5 \leq \Delta T < 4.0$
G	$4.0 \leq \Delta T$

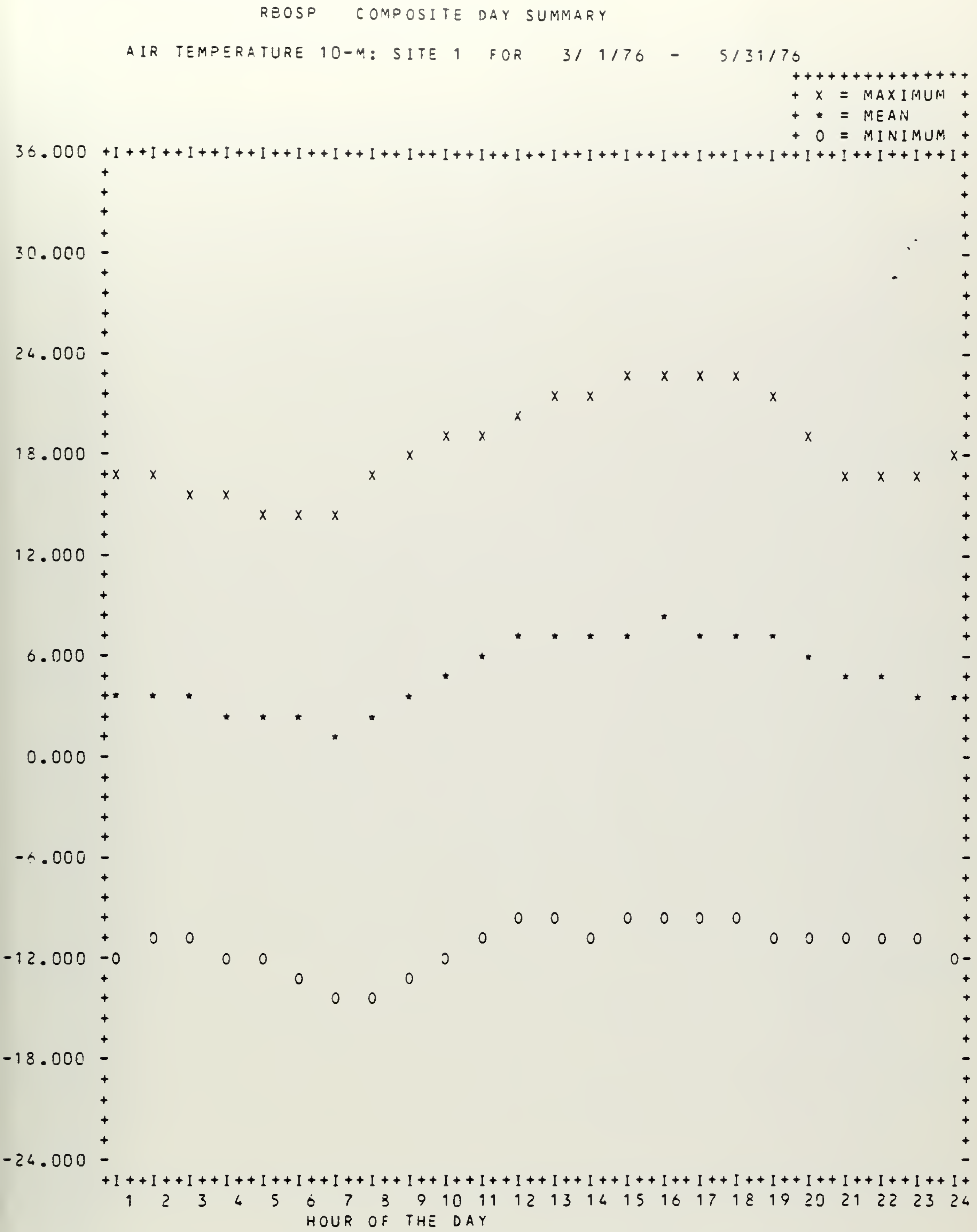


Figure 2.2-9. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

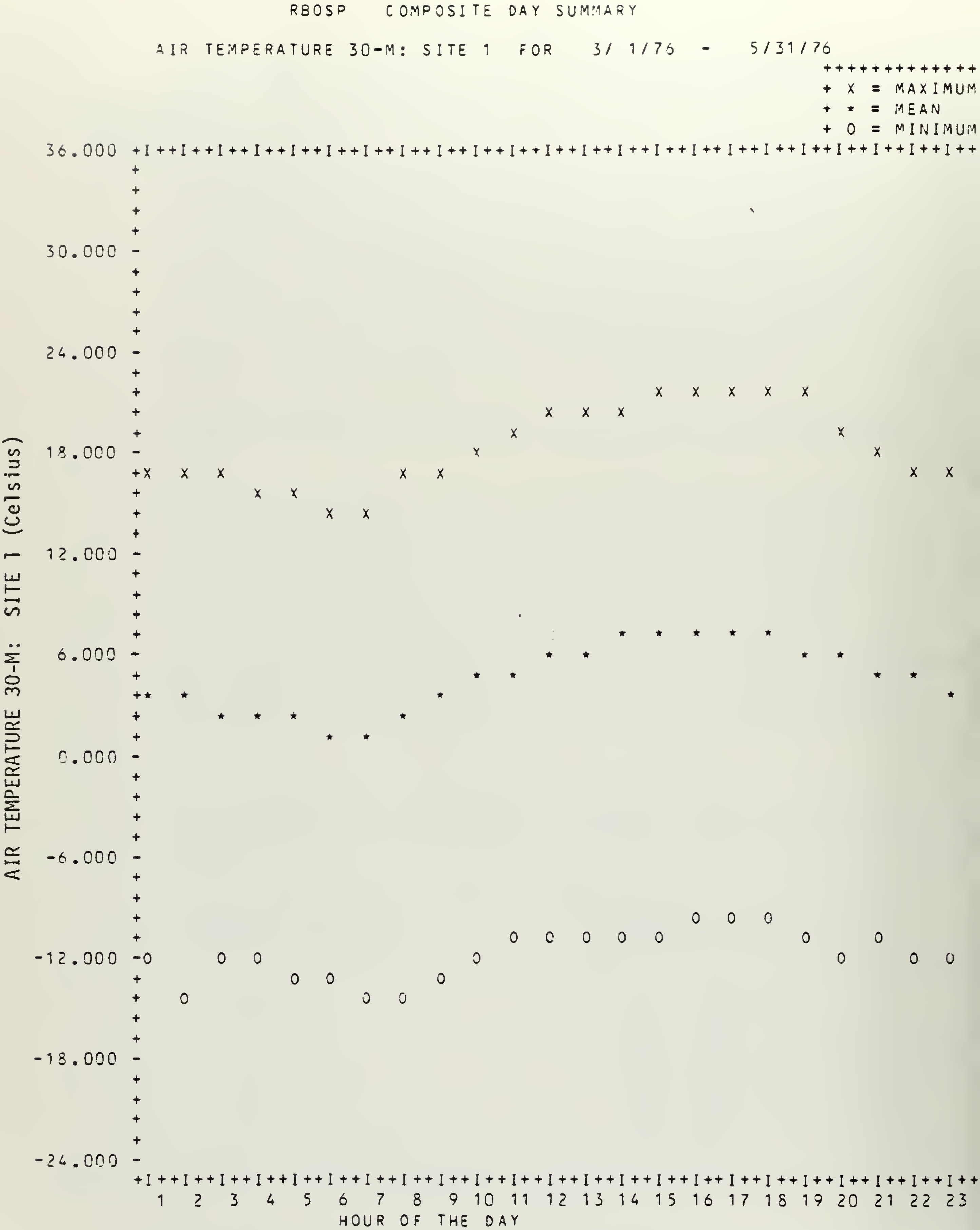


Figure 2.2-10. Air temperature, 30-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

RBOSP COMPOSITE DAY SUMMARY

AIR TEMPERATURE 10-M: SITE 2 FOR 3/ 1/76 - 5/31/76

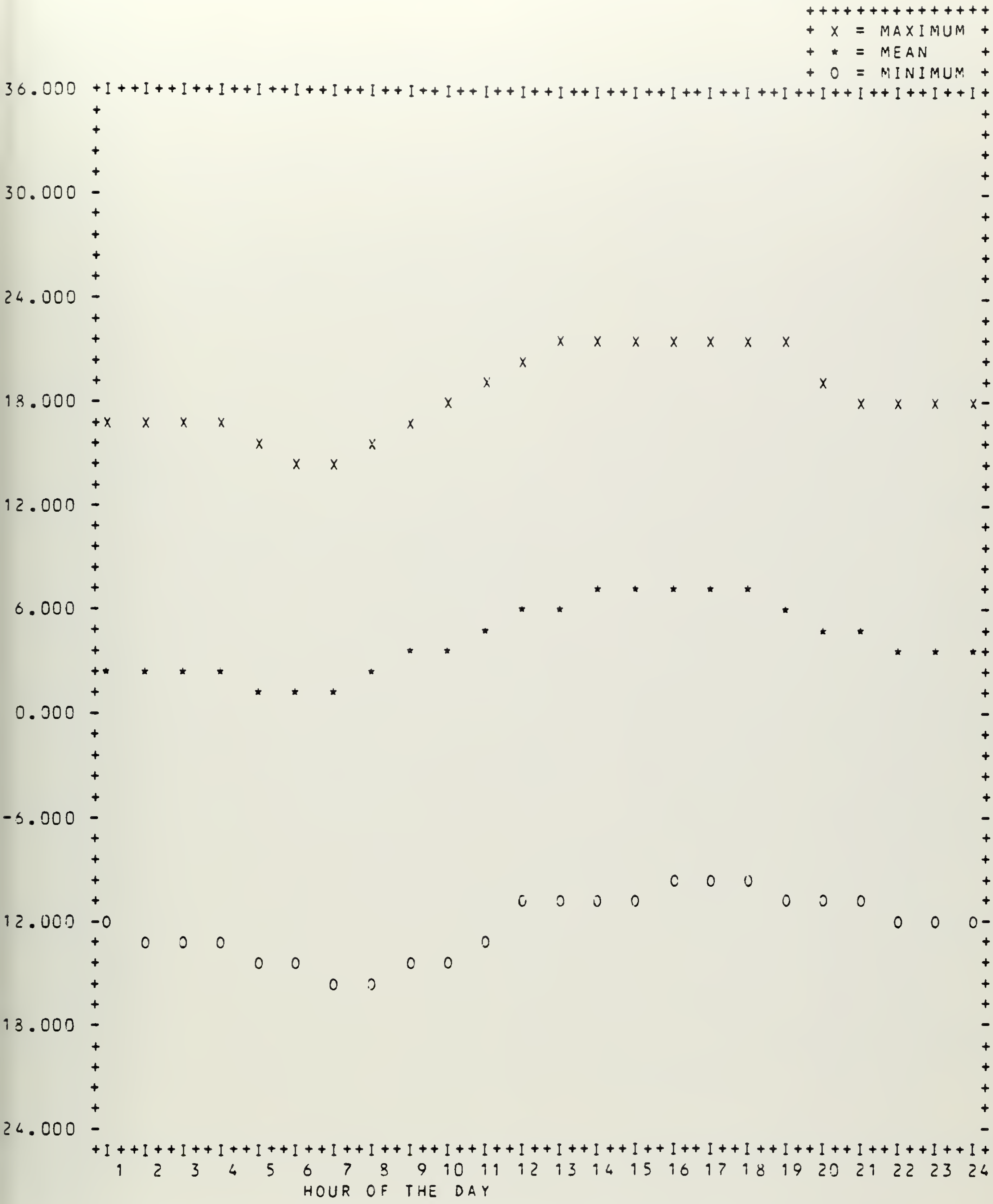


Figure 2.2-11. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 2, RBOSP.

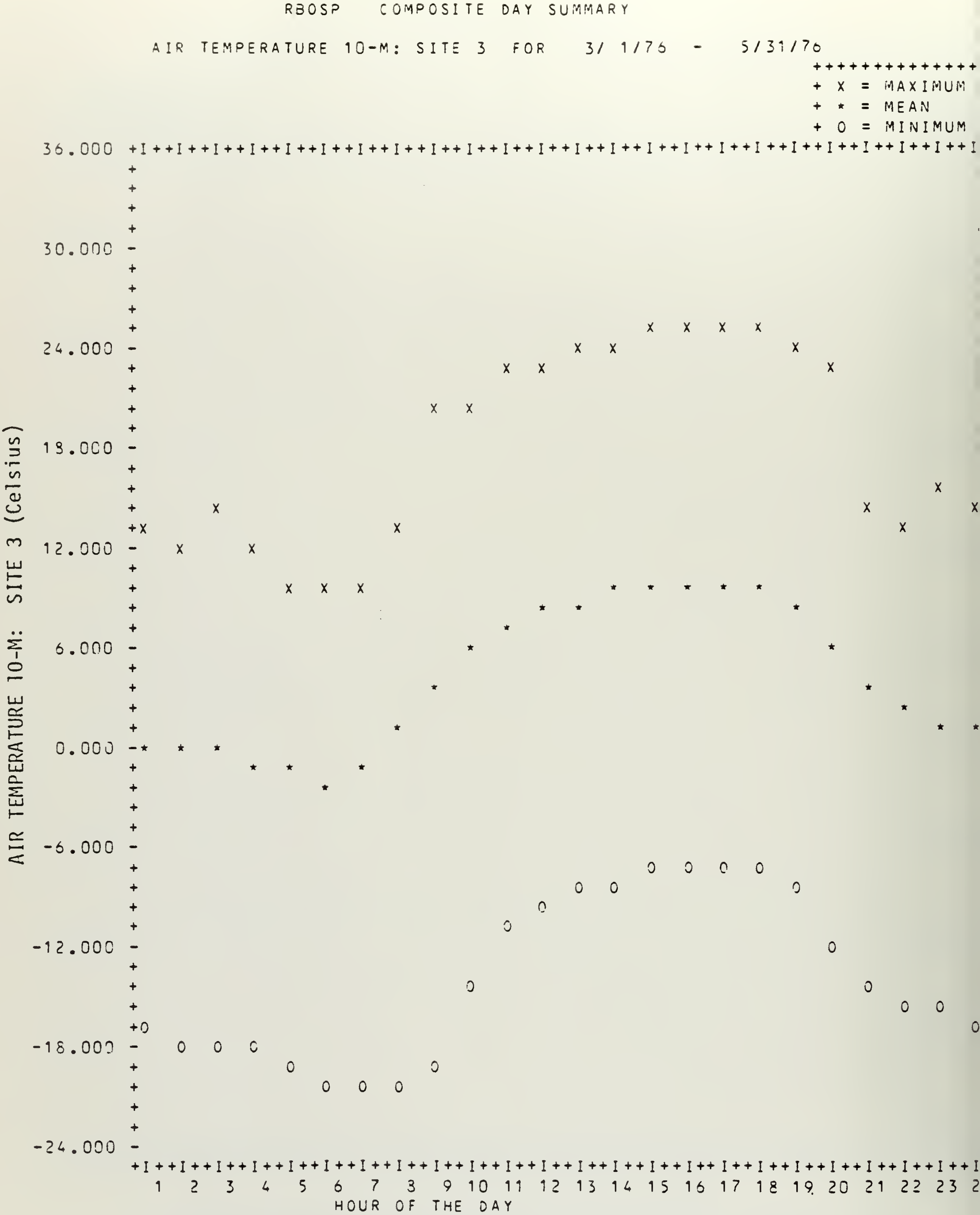


Figure 2.2-12. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 3, RBOSP.

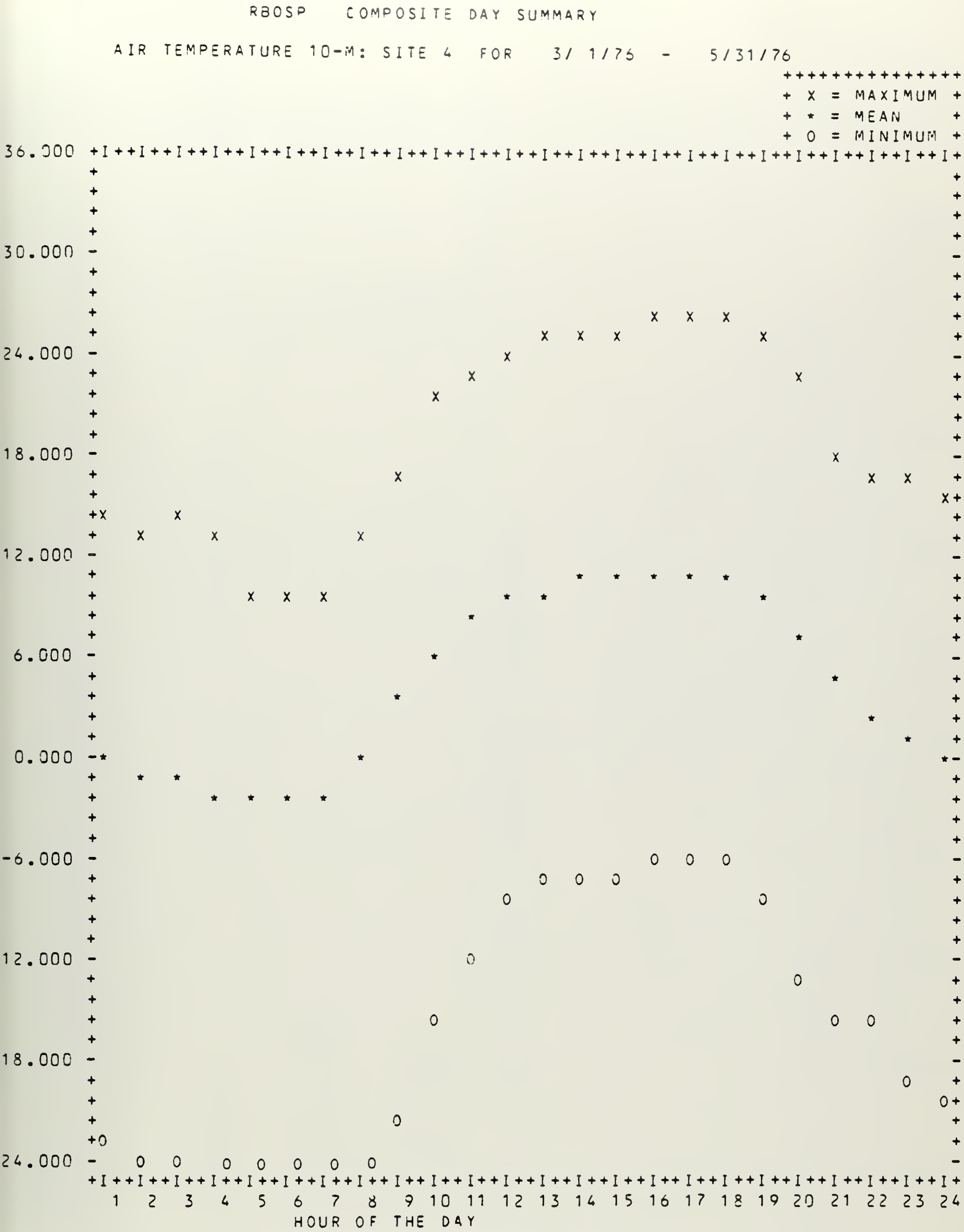


Figure 2.2-13. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 4, RBOSP.

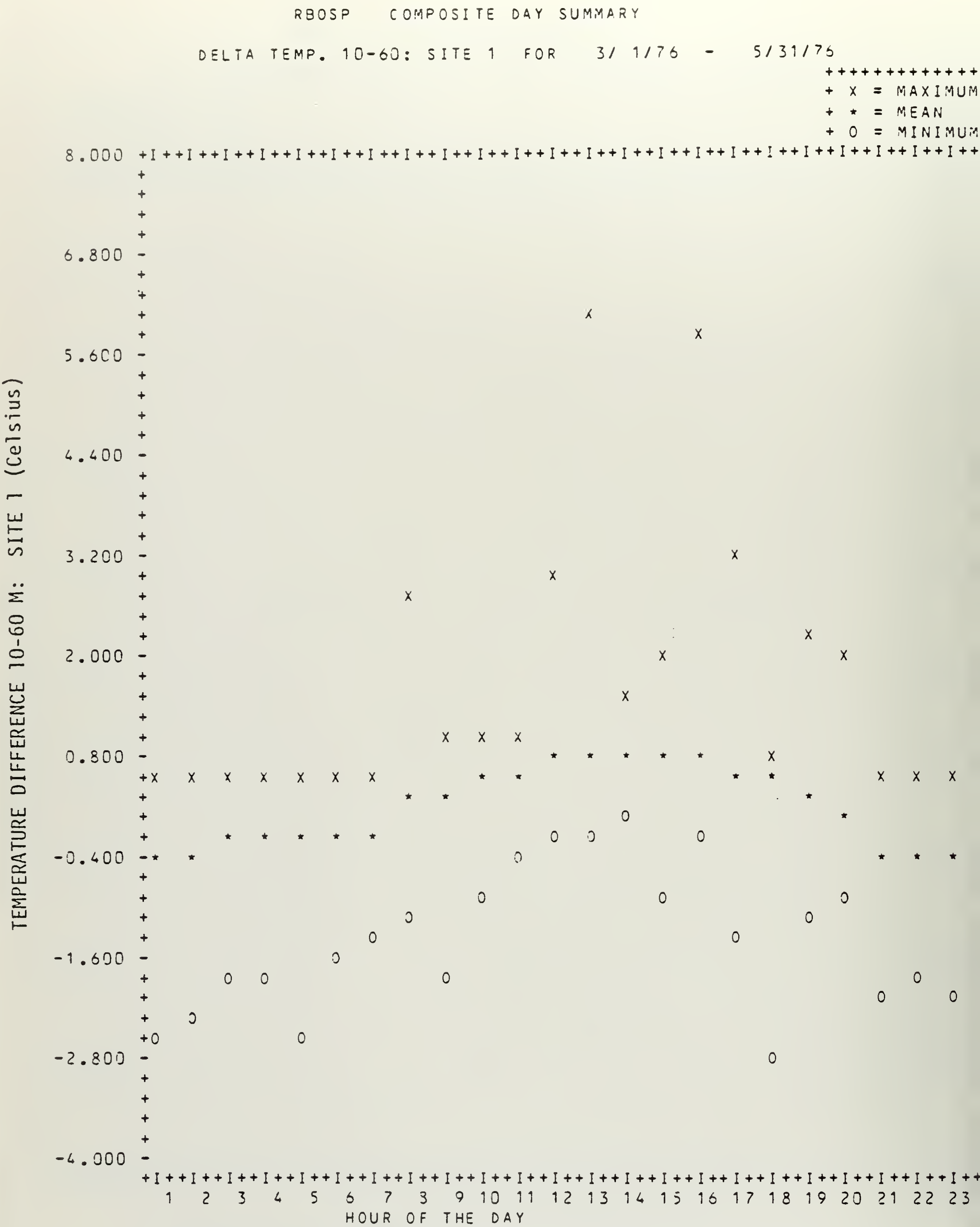


Figure 2.2-14. Temperature difference between 10-m and 60-m levels (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

Table 2.2-2. Percent of occurrence of the Pasquill stability classes at Site 1. Stability category determined from the temperature difference between the 10- and 60-m levels during the Spring 1976, RBOSP.

Stability Classification	Pasquill Categories	Temperature Change with Height (C/100 m)	Percent of Occurrence	Mean Wind Speed (mph)
Extremely Unstable	A	Less than -1.9	7.27	11.95
Moderately Unstable	B	-1.9 to -1.7	4.14	11.70
Slightly Unstable	C	-1.7 to -1.5	5.35	10.01
Neutral	D	-1.5 to -0.5	35.21	8.46
Slightly Stable	E	-0.5 to 1.5	39.35	6.24
Moderately Stable	F	1.5 to 4.0	8.29	6.74
Extremely Stable	G	Greater than 4.0	0.39	8.12

SOURCE: David H. Slade, Editor, Meteorology and Atomic Energy Nat. Tech. Serv. TID-24190, pp. 102-103, 1971.

Category A has the highest average wind speed and E has the lowest. The slightly stable Category E occurred most often during nighttime hours with F and G occurring in early morning hours.

Figure 2.2-15 graphically presents the minimum, maximum, and mean composite day relative humidities as a function of hour of day for Spring 1976. The relative humidity data were taken at the 10-m level at Site 1. There was a significant decrease (12%) in the mean relative humidity at sunrise. The effect is probably due to the surface heating of the air. This composite daily transition period occurs over 4 hours. The decrease may also arise from the increased thermally generated turbulent mixing caused by the reversal of the mean lapse rate from slightly stable to slightly unstable and the increased surface temperature.

2.2.3 Miscellaneous

The meteorological parameters grouped into this category are precipitation, evaporation, solar radiation, noise, visibility, snow course, and tracer studies. All these parameters, except precipitation, tracer studies, and evaporation, are measured only at Site 1. Evaporation measurement is made at Site 3 because of water availability. The evaporation rate and visibility are not monitored continuously, but are recorded on a routine basis.

2.2.3.1 Precipitation Measurements

The precipitation data summary for Spring 1976 is presented in Table 2.2-3. The total and daily amounts of precipitation are shown for each site. Maximum total precipitation for 1 day was 0.52 inch at Site 4 on 2 March 1976.

Site 4 registered the largest total precipitation (2.76 inches for Spring 1976).

2.2.3.2 Evaporation Measurements

Data for Spring 1976 are presented in Table 2.2-4. Measurements were started for the 1976-1977 baseline data year with the measurement on 30 April 1976. The highest evaporation rate recorded was 0.020 g/cm^2/h This occurred during the week ending 21 May 1976. The minimum evaporation rate was 0.014 g/cm^2/hr occurring during the measurement period ending 30 April 1976.

2.2.3.3 Solar Radiation Measurement

Solar radiation data were taken at 1.2 m above ground level at Site 1. The minimum, maximum, and mean composite day solar radiation measurements as a function of hour of the day for Spring 1976 are graphically presented in Figure 2.2-16. The seasonal and hourly minimum, maximum, and mean values of the solar radiation are presented in Table 2.2-5.

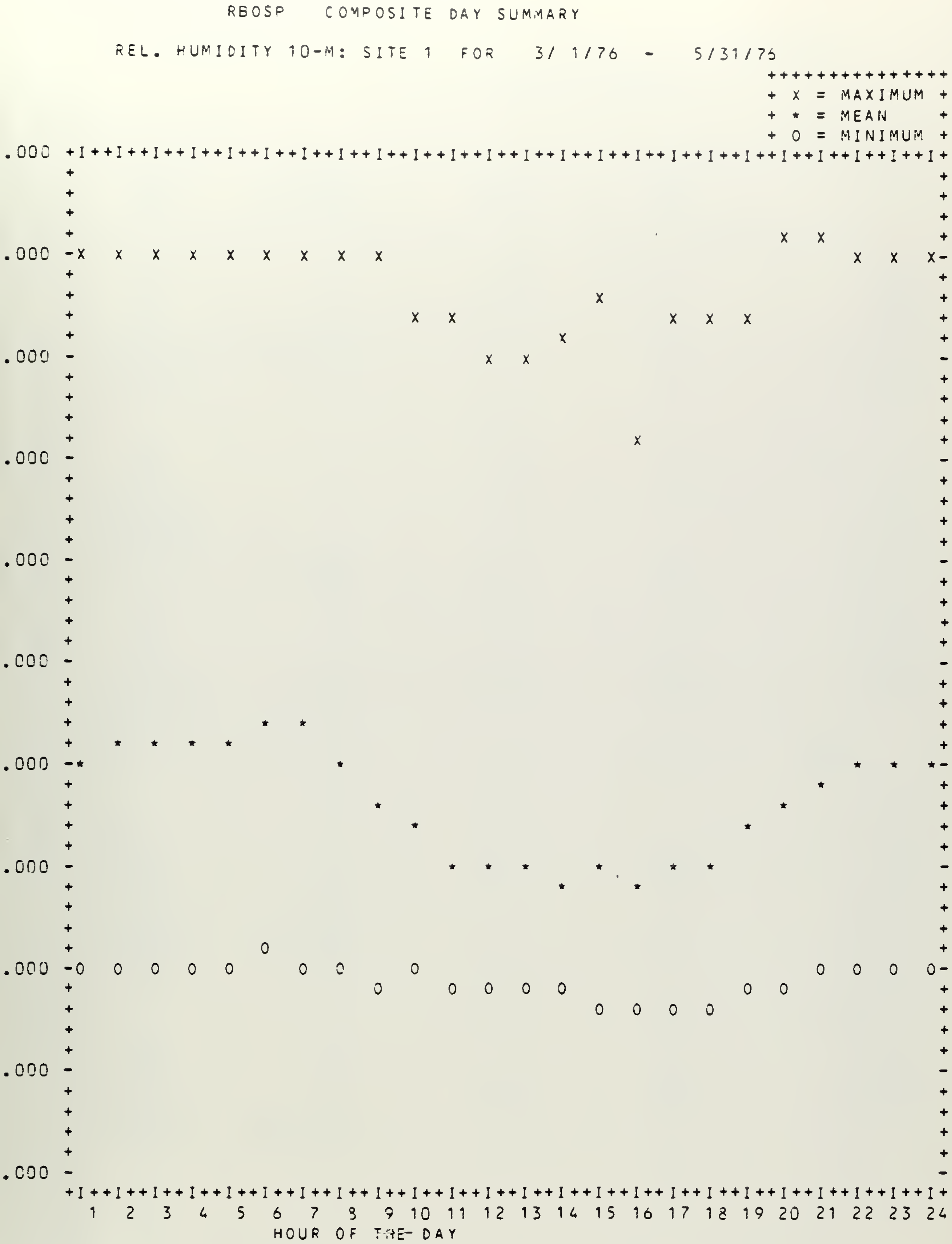


Figure 2.2-15. Relative humidity, 10-m level (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

Table 2.2-3. Precipitation data for Spring 1976; values are presented in inches of water, RBOSP.

Date	Site 1 Total	Site 2 Total	Site 3 Total	Site 4 Total
3/1/76	--	--	0.01	0.06
3/2/76	--	0.02	0.25	0.52
3/3/76	--	--	0.02	--
3/4/76	0.12	0.03	0.13	0.12
3/11/75	0.02	--	0.04	0.01
3/14/76	--	--	--	0.01
3/25/76	0.30	0.04	0.18	0.03
March Total	0.44	0.09	0.63	0.75
4/5/76	0.14	0.05	0.05	0.15
4/7/76	--	--	--	0.01
4/12/75	--	0.01	0.01	0.05
4/14/76	0.06	0.04	0.03	0.11
4/17/76	0.05	0.07	0.02	0.09
4/18/76	0.11	0.10	0.08	0.33
4/19/76	--	--	--	0.01
4/23/76	0.04	0.03	0.03	0.05
4/26/76	0.10	0.11	0.04	0.06
4/27/76	--	0.01	0.04	0.01
April Total	0.50	0.42	0.30	0.87
5/4/76	--	--	0.02	--
5/6/76	--	0.01	0.01	--
5/7/76	--	--	0.18	0.03
5/8/76	0.15	0.03	0.35	0.32
5/9/76	0.08	0.02	0.03	0.05
5/10/76	--	--	0.03	0.12
5/11/76	--	0.09	0.03	0.01
5/19/76	0.01	--	0.01	0.02
5/20/76	--	0.51	0.30	0.14
5/21/76	--	0.08	--	--
5/22/76	0.02	0.01	0.01	--
5/23/76	--	--	0.01	0.03
5/24/76	0.15	0.19	0.19	0.23
5/25/76	0.39	0.26	0.16	0.16
5/30/76	0.13	0.21	0.07	0.03
May Total	0.93	1.41	1.40	1.14
Spring Total	1.87	1.92	2.33	2.76

End Date of Measurement Period	Time of Measurement Hours (MST)	Precipitation Since Last Reading (in.)	Maximum Temperature Since Last Reading (C)	Minimum Temperature Since Last Reading (C)	Water Required To Fill Pan (in.)	Evaporation Rate $(g/cm^2/hr)$
4/30/76	1400	0.11	17^{o}	3^{o}	0.95	0.014
5/7/76	0945	0.02	19^{o}	3^{o}	1.08	0.017
5/14/76	1500	0.59	23^{o}	3^{o}	0.41	0.015
5/21/76	1745	0.20	28^{o}	7^{o}	1.16	0.020
5/29/76	1520	0.37	22^{o}	5^{o}	0.90	0.015

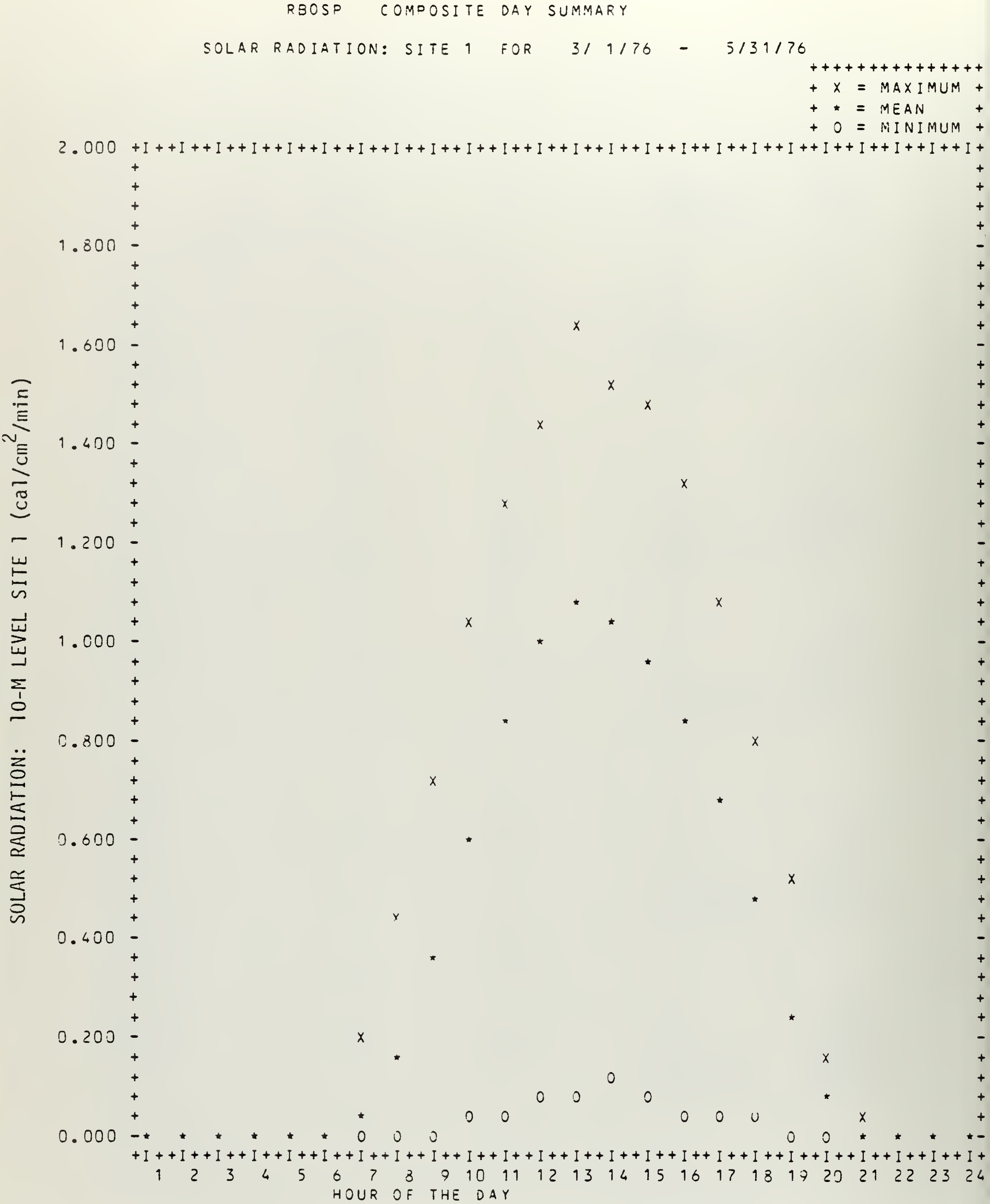


Figure 2.2-16. Solar radiation (minimum, maximum, and mean by hour of the day) for Spring 1976 at Site 1, RBOSP.

Table 2.2- 5. Solar radiation, seasonal and monthly summary for Spring 1976, values are in Langleys or cal/cm^2/min, RBOSP.

	March	April	May	Spring 1976
Minimum	0.00	0.00	0.00	0.00
Maximum	1.37	1.52	1.63	1.63
Mean	0.29	0.36	0.39	0.35

2.2.3.5 (a) Visibility Measurements (on tract)

During Spring 1976, visibility ranged from 3 to 150 miles for each period that data were recorded. The 3 mile visibility occurred on 7 May 1976 (Tables 2.2-6 through 2.2-8).

2.2.3.5 (b) Visibility Measurements (Piceance Creek Basin Area)

Visual range measurements for the Piceance Creek Basin are made as a cooperative effort between lessees of Tracts C-a and C-b. These measurements are made independently of the measurements reported in 2.2.3.5 (a) above, and represent different techniques and sampling sites. The data, therefore, compliment each other but are not directly comparable. Methods used in the two studies are presented in previous progress reports.

Approximately 390 visibility measurements were made during the Spring quarter (March, April, May) 1976. This represented an 87% recovery of data over the 16-day measurement period. Spring snowstorms accounted for most data loss.

Fluctuations in daily mean visual ranges were less pronounced during the Spring quarter than the two previous quarters. Daily mean visual range (at 6-day intervals) varied less than 30 miles (Table 2.2-9) with the exception of a variation of 56 miles during the first week in April.

Fluctuations in daily mean visual ranges of the four different views were comparable, i.e., when visual range decreased in one view, it was generally accompanied by a similar decrease in the other three views.

The greatest mean visual ranges were recorded on clear days with no haze -- 1 April and 31 May, with a mean visual range of 101 and 88 miles, respectively. Lowest mean visual ranges were recorded when passing snowstorms obscured the field of view (45 and 37 miles, respectively).

Table 2.2-6. Visibility data for March 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hours (Inches)	Sector Visibility N	E	S	W	Prevailing Visibility (miles)	Comments
3/5/76*	1340	--	80	80	80	80	80	Est. cloud cover 10%
3/8/76	1200	--	150	150	150	150	150	Est. cloud cover <1%
3/11/76	1230	0.01	4	45	45	4	45	Est. cloud cover 80%
3/14/76	1242	--	40	40	100	40	100	Est. cloud cover 95%
3/18/76	1430	--	150	150	150	150	150	Est. cloud cover 45-50%
3/20/76	1200	--	80	80	>80	>80	80	Est. cloud cover 5%
3/23/76	1200	--	100	100	100	100	100	Est. cloud cover 80%
3/26/76	1300	0.31	>150	>150	>150	>150	150	Est. cloud cover 5%
3/29/76	1240	--	10	80	20	10	20	Est. cloud cover 60%

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* No measurement made on 3/2/76; site access impaired by blowing snow conditions.

Date of Observation	Time of Observation Hours (MST)	in Prior 24 hours (Inches)	Sector Visibility N	E	S	W	Prevailing Visibility (miles)	Comments
4/1/76	1400	--	>120	>120	>120	>120	>120	Est. cloud cover 50%
4/4/76	1110	--	150	150	150	150	150	Est. cloud cover 20%
4/7/76	1715	--	80	80	80	80	80	Est. cloud cover 99%
4/10/76	1325	--	120	120	120	120	120	Est. cloud cover <5%
4/13/76	1200	--	80	>80	>80	80	80	Est. cloud cover 65%
4/16/76	1645	--	8	4	4	3	8	Est. cloud cover 75%
4/19/76	1515	--	>100	>100	>100	>100	>100	Est. cloud cover 65%
4/22/76	1200	--	4	100	100	4	100	Est. cloud cover 30%
4/25/76	1015	--	>100	>100	>100	>100	>100	Est. cloud cover 85%
4/28/76	1250	--	100	100	100	100	100	Est. Cloud cover <1%

Table 2.2-8 . Visibility data for May 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hours (Inches)	Sector Visibility N	E	S	W	Prevailing Visibility (miles)	Comments
5/1/76	1430	--	>120	>120	>120	>120	>120	Est. cloud cover <1%
5/4/76	1145	--	70	70	70	70	70	Est. cloud cover 75%
5/7/76	1130	0.04	3	3	5	5	5	Est. cloud cover 80%
5/10/76	1530	--	100	100	100	100	100	Est. cloud cover 80%
5/13/76	0740	--	>150	>150	>150	>150	>150	Est. cloud cover 10%
5/16/76	1315	--	100	100	100	100	100	Est. cloud cover <1%
5/19/76	1040	--	30	20	80	30	20	Est. cloud cover 90%
5/22/76	0815	--	100	100	100	100	100	Est. cloud cover 98%
5/25/76	1245	0.05	8	60	60	60	60	Est. cloud cover 75%
5/28/76	1125	--	20	20	50	20	50	Est. cloud cover 45%
5/31/76	1225	0.15	100	100	100	100	100	Est. cloud cover 70%

Table 2.2-9. Mean visual range (in miles) for each day of monitoring (6 to 7 hours data) from four views in the Piceance Creek Basin, Colorado.

Date	Mean Visual Range
March 2, 1976	37[1]
8	61
14	65
20	85
26	75
April 1, 1976	101
7	45
13	48
19	56
25	72
May 1, 1976	75
7	56
13	76
19	58
25	65
31	88

[1] Based on 2 hours of data

Monthly mean visual ranges are shown in Table 2.2-10 below. There was little variation in the means between quarters.

Table 2.2-10. Visual range (miles) for all views combined for each month of monitoring in the Piceance Creek Basin, Colorado.

Month	Mean	Maximum	Minimum	Standard Deviation
March	70	116	27	19.2
April	67	138	14	27.7
May	70	124	27	16.7

The highest frequency of relatively low visual ranges during the quarter occurred in April, as did the greatest fluctuation (Figure 2.2-17).

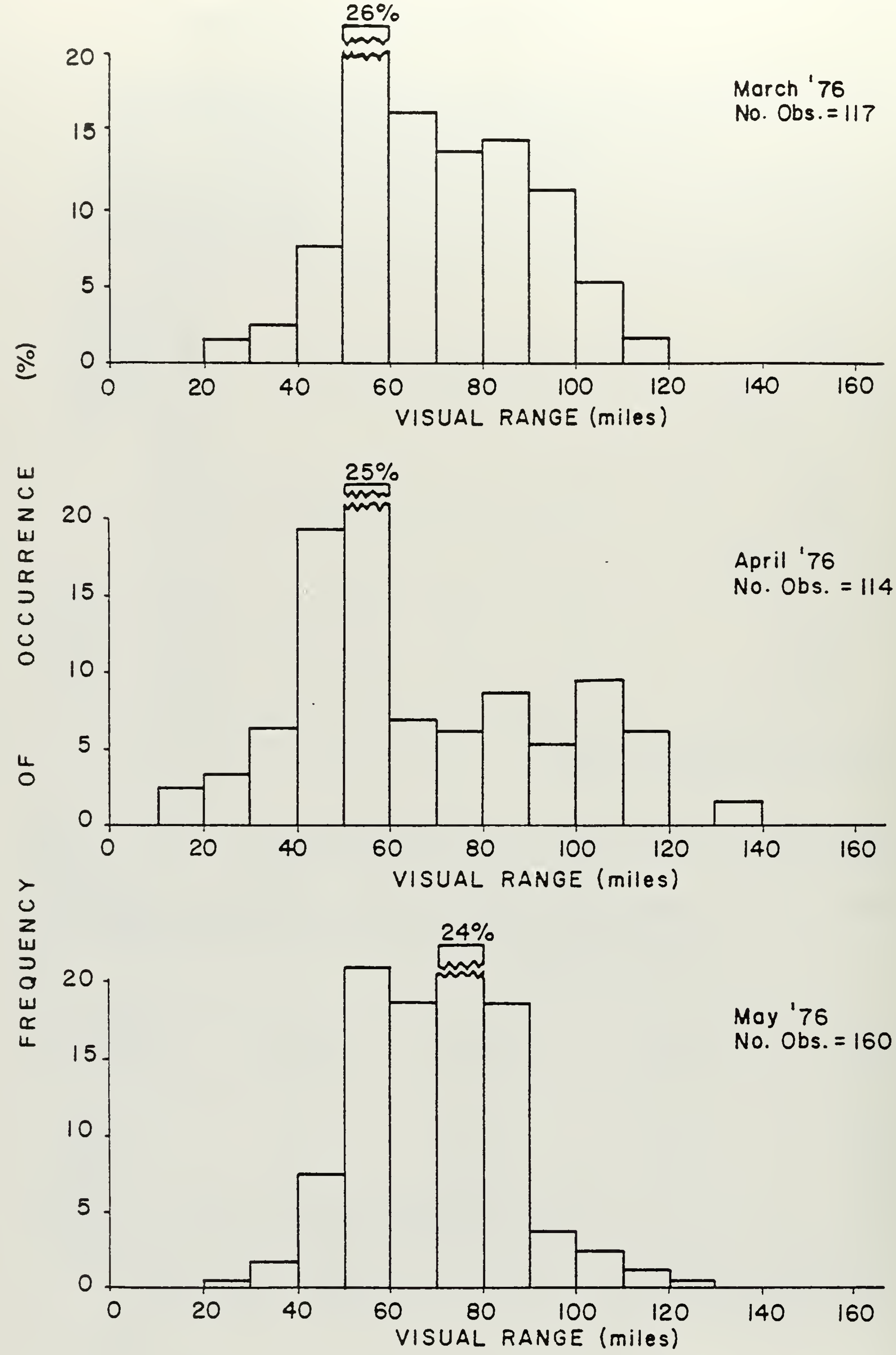

Figure 2.2-17. Monthly composite distribution of visual range, Piceance Creek Basin, Colorado, Spring 1976.

In general, visual ranges were high during the Spring quarter. Ninety-five percent of the visual range measurements for each view exceeded 39 miles; 50% exceeded 67 miles. A summary of visual range for each of the four views for the season is given in Table 2.2-11.

Table 2.2-11. Summary of visual range (in miles) for all four views and a composite in Piceance Basin, Colorado, Spring 1976.

View	Mean	Maximum	Minimum	5[1] Percentile	Standard Deviation
I	74	118	39	50	18.9
II	63	113	32	40	16.5
III	67	118	14	25	22.3
IV	73	138	27	38	24.5
Composite	69	138	14	39	21.1

[1] 5 percentile is that value above which fall 95% of the measurements.

The maximum visual range was recorded from View IV; the minimum visual range from View III. Mean visual ranges between the four views did not differ appreciably during the quarter.

The general state of visibility, independent of direction, is shown as a composite distribution of all visual range measurements during the spring quarter in Figure 2.2-18. These data indicate that visual range for the basin most frequently falls between 50 and 60 miles. The generalized visibility (composite mean visual range) for the spring was 69 miles.

Mean hourly visual ranges for each view and a composite of all views are shown in Figure 2.2-19. Hourly fluctuations in the mean visual range of views I and II exhibit a general similarity, with the exception of a mid-morning increase in mean visual range in View II. Mean hourly visual ranges for views III and IV are also similar during an average day. The composite data show a slight decrease in visual range over the course of a day. No conclusions can be drawn concerning the trends shown in Figure 2.2-19 until more data are available.

.2.3.7 Snow Course Measurements

Snow course measurements for Spring 1976 are presented in Table 2.2-12. The maximum snowfall measured for Spring 1976 was 8.0 in. Snow course measurements were discontinued 30 April 1976, unless a significant snowfall occurs.

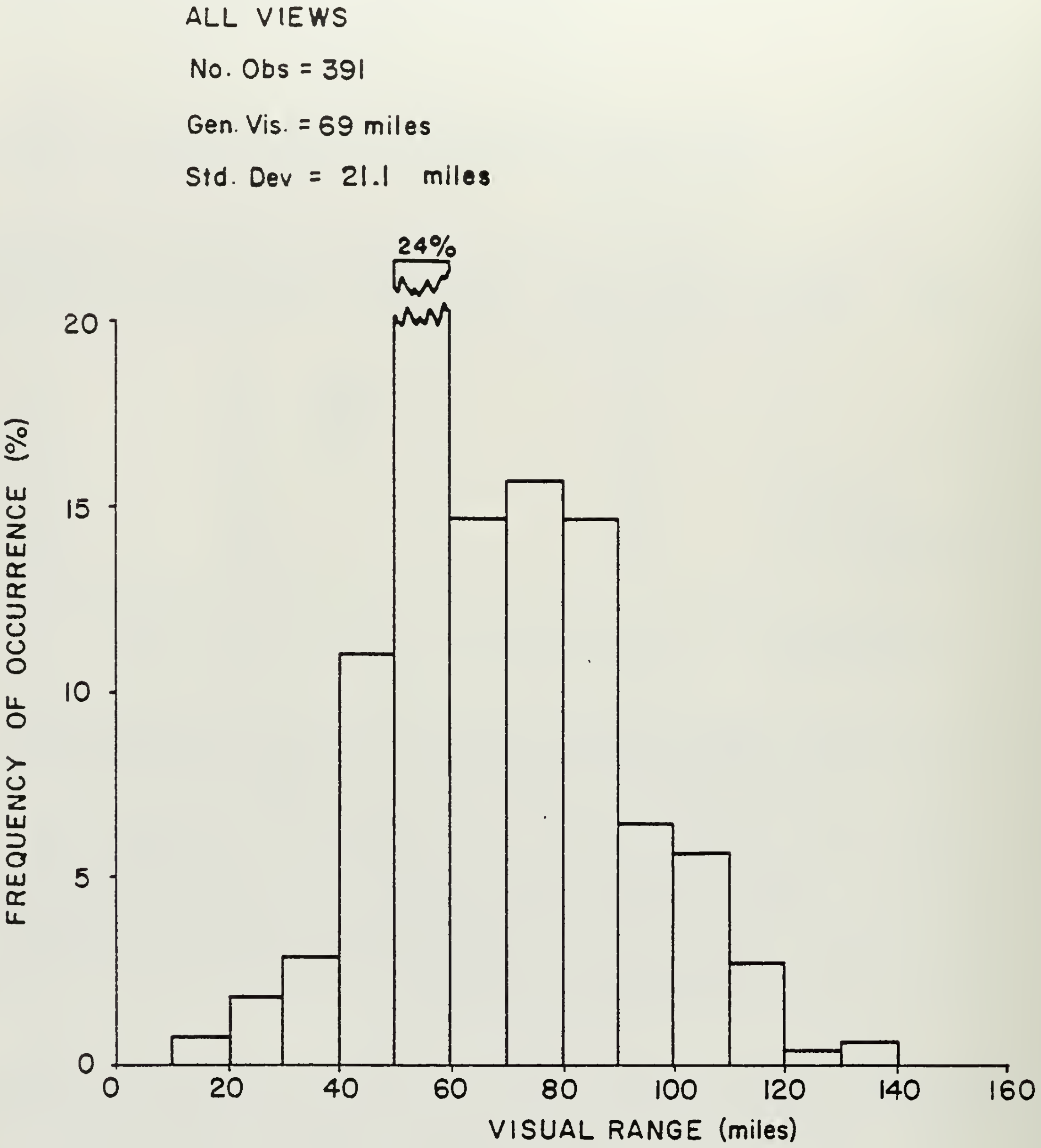

Figure 2.2-18. Composite Visual Range Distribution, Piceance Creek Basin, Colorado, Spring 1976.

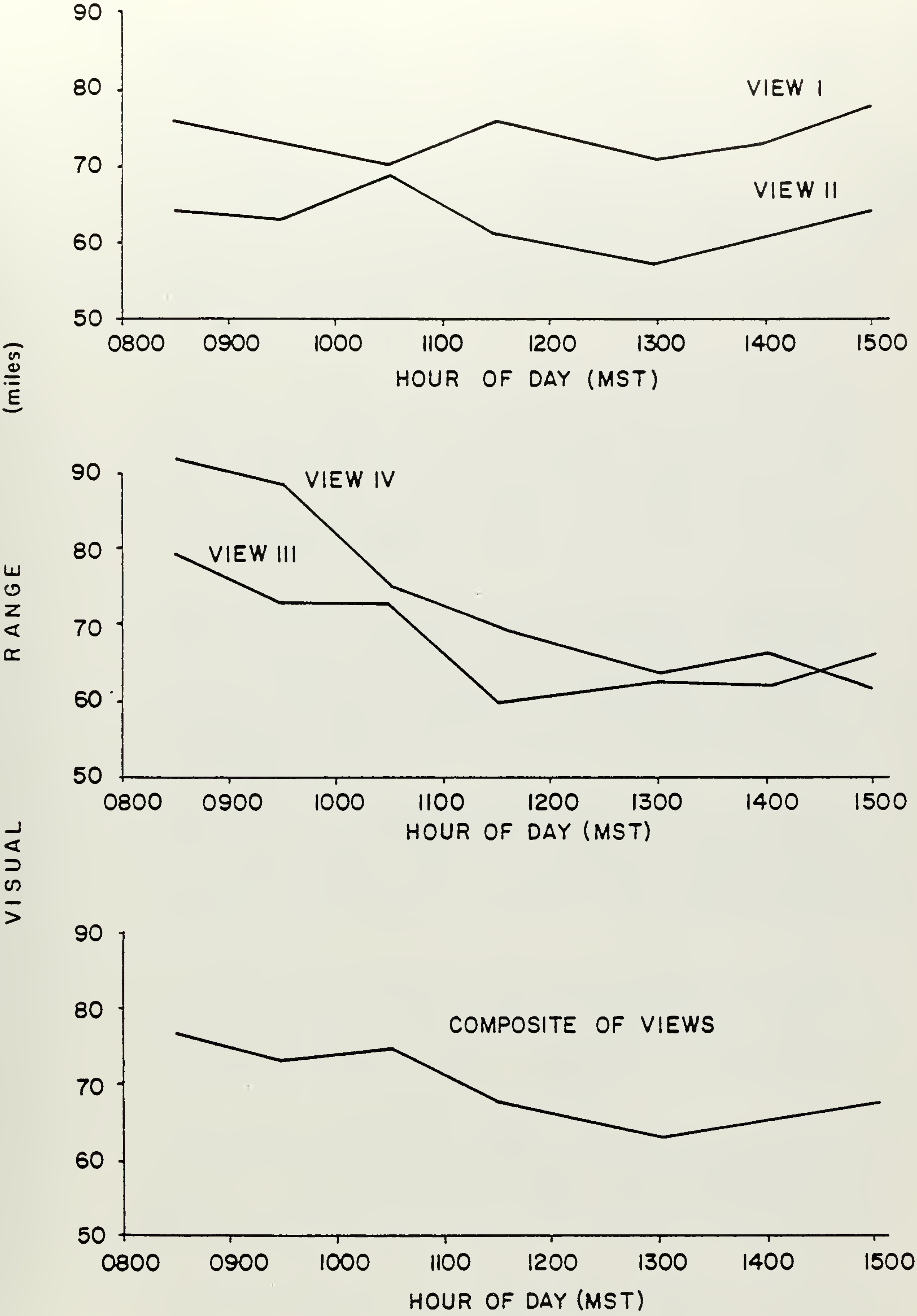

Figure 2.2-19. Variation in the mean hourly visual range, Piceance Creek Basin, Colorado, Spring 1976.

Table 2.2-12. Snow course measurements for Spring 1976, RBOSP.

Date of Sample	Total Snow Depth (in.)	Water Equivalent (in. of H_2O)
3/3/76	6.5	0.13
3/5/76	8.0	0.14
3/26/76	3.0	0.10

2.3 TERRESTRIAL STUDIES

2.3.1 Vegetation

Ten different vegetation types were sampled on or near Tract C-a during May 1976. Thirty-five permanent transects were sampled only for the herbaceous stratum in May, while 27 non-permanent transects were sampled for shrub and tree strata. Permanent and non-permanent transect data were combined to provide an accurate description of the study area vegetation types.

The flora identified to date in the Tract C-a study area includes 5 tree species, 37 shrub species, 160 forb species and 46 grass and/or grasslike species. All species have been placed into one of four life form categories: tree, shrub, herbaceous or non-grasslike, and grass or grasslike (see Section 7.1.A, Table 3-7-3 of the Annual Report). A shrub, _Tamarix pentandra_ (Tamarisk), is the only addition to this species list.

Aspen - The aspen type on the study area was sampled with two permanent and one non-permanent transect. The aspen type is characterized by the constant dominance of aspen and dense and diverse shrub and herbaceous strata, consisting primarily of mountain snowberry, chokecherry and Utah serviceberry in the shrub stratum, and elk sedge in the herbaceous stratum.

Aspen ranges in elevation from 2481 to 2591 m (8,140 to 8,560 ft). The type typically occurs on steep, north and east-facing slopes. The soils are deep, sandy loams which have large accumulations of organic matter. Aspen is bordered at higher elevations by Douglas-fir and at lower elevations by mixed brush.

The mature tree stratum contributed a total cover of 31%. Aspen dominated the tree stratum with a relative cover of 100%, a basal area of 4.0 m^2 per hectare, and a density of 383 individuals per hectare. Douglas-fir was found only in 20% of the tree and shrub quadrats.

Five species provided 47% total cover and a total density of 8,017 individuals per hectare for the shrub-tree seedling stratum. Utah serviceberry, common black chokecherry and mountain snowberry were the dominant species, contributing 44% of the total cover.

Fourteen species and one unknown contributed 1% total herbaceous stratum cover. Elk sedge was the dominant herbaceous species in the aspen type, providing 53% relative cover.

Douglas-fir - The Douglas-fir type was sampled with two permanent and one non-permanent transect. The type is characterized by the constant dominance of Douglas-fir and a dense and diverse shrub stratum. The herbaceous stratum is dominated by elk sedge. Douglas-fir is restricted to the higher elevations of the study area near the summit of Cathedral Bluffs. This type occurs in shallow soils on steep north and east-facing slopes.

Douglas-fir dominates the tree stratum, providing 51% total cover and occurring at a density of 333 individuals per hectare. Total basal area for Douglas-fir was 40 m^2 per hectare.

The shrub stratum in the Douglas-fir type consists of two layers. The upper layer is dominated by Saskatoon serviceberry, which occurs in large clones. The lower layer is dominated by mountain snowberry. Both of these shrub species provide 92% relative cover and 87% relative density.

In the herbaceous stratum, 10 species contributed only 1% total cover. The dominant species was elk sedge, which provided a relative cover of 94%.

Mixed Brush - The mixed brush type was sampled with five permanent and four non-permanent transects. Two strata and 54 species were identified for the mixed brush type. Mixed brush is characterized by the tall shrub life form of Utah serviceberry, Gambel oak and true mountain mahogany. The type ranges in elevation from 2179 to 2621 m (7,150 to 8,600 ft) and grows on a wide range of slopes, from steep to gentle. Mixed brush grows on all slope aspects, but best shrub development is found on steep north and east-facing slopes.

The shrub stratum shows a wide range of diversity with up to 10 species providing 63% total cover. Utah serviceberry, big sagebrush and mountain snowberry are the dominant shrub species, respectively providing a relative cover of 30, 30 and 18%.

In the herbaceous stratum, 44 species contributed 1% total cover. Elk sedge was the dominant herbaceous species, providing a relative cover of 33%.

Pinyon-Juniper - The pinyon-juniper type was sampled with seven permanent and eight non-permanent transects. Three strata and 50 species were identified for the type: 2 species in the mature tree stratum, 10 species in the shrub stratum and 38 species in the herbaceous stratum. Pinyon-juniper is the most extensive vegetation type on the study area and is dominated by pinyon pine and Utah juniper. Pinyon-juniper ranges in elevation from 1798 to 2438 m (5,900 to 8,000 ft). The type occurs on all slope aspects and occupies ridges, canyons or steep slopes where shallow, coarse rocky soils predominate.

The tree stratum of pinyon-juniper is usually very open with the individual trees well spaced (337 individuals per hectare). Pinyon pine and Utah juniper contribute 23% total cover and a basal area of 31 m^2 per hectare. Pinyon pine contributed a slightly higher percent cover (14%) than Utah juniper (8%).

In the shrub stratum, 10 species provided 14% total cover and a total density of 3,687 individuals per hectare. Big sagebrush is the dominant species and provided a relative cover of 38% and a relative density of 48%. Other dominants include Utah serviceberry and antelope bitterbrush.

The herbaceous stratum is characterized by a high diversity (37 species), but a low total cover, < 1%. The dominant species were three grasses, slender wheatgrass (25% relative cover), Sandberg bluegrass (37% relative cover) and needle-and-thread grass (7% relative cover).

Sagebrush - The sagebrush type was sampled with seven permanent and eight non-permanent transects. The type is characterized by the constant dominance, high cover and high density of big sagebrush in the shrub stratum. Two strata and 78 species were identified for the sagebrush type: 17 species in the shrub stratum and 61 species in the herbaceous layer.

Sagebrush occurs over a wide elevational range, 1945 to 2621 m (6,380 to 8,600 ft). The type generally occurs on gentle slopes and grows on all slope aspects. Sagebrush intergrades with pinyon-juniper at lower elevations along drainages and on uplands along the ridges above the major drainages. Sagebrush also intergrades with mixed brush on upland slopes.

The shrub stratum contains 17 species and contributed 49% total cover. Big sagebrush is the dominant species, providing 68% relative cover and occurring at 56% relative density. Frequent associates in the sagebrush type are rabbitbrush and mountain snowberry.

In the herbaceous stratum, 60 species contribute only a total cover of 2%. The dominant species are Sandberg bluegrass, silvery lupine and flowery phlox. Other species commonly encountered include western wheatgrass, scarlet globemallow and Richardson tanseymustard.

Greasewood - The greasewood type was sampled with three permanent transects. These permanent transects provide data on seasonal and annual vegetation changes for the herbaceous stratum.

Greasewood occurs as small isolated patches within bottomland sagebrush stands. It is frequently an indicator of saline-sodic soils and occurs on deep, well-drained soils formed in alluvial deposits which have dependable groundwater sources.

The greasewood herbaceous stratum contained eleven species that had a total coverage of only 3%. Richardson tanseymustard and bluestem wheatgrass were the dominant species for this type. Other important species include annual stickseed, lambsquarter, goosefoot and slimleaf goosefoot.

Rabbitbrush - The rabbitbrush type was sampled with two permanent transects. These permanent transects provide seasonal and annual vegetation changes for the herbaceous stratum in this vegetation type.

The rabbitbrush communities sampled represent a seral stage in the bottomalnd sagebrush. The high density rabbitbrush stands are the results of rapid invasion by rabbitbrush into abandoned agricultural or burned sites which were formerly dominated by big sagebrush.

In the herbaceous stratum, thirteen species contributed 5% total cover. Great basin wild-rye was the dominant species, with cheatgrass brome, squirreltail and Richardson tansey-mustard as other frequent associates.

Bald - The bald type (upland meadow) is characterized by the absence of developed tree and shrub strata and a diverse herbaceous cover consisting of perennial forbs and grasses. The bald type was sampled with two permanent and three non-permanent transects. Two strata and 36 species were identified: 5 species in the shrub stratum and 31 species in the herbaceous stratum. The bald type ranges in elevation from 2231 to 2262 m (7,320 to 8,600 ft) and occurs almost exclusively on west slope aspects facing the prevailing wind.

In the shrub stratum, five species provided a 10% total cover. Gray horsebrush was the dominant shrub providing 47% of the relative cover. Other commonly encountered species include big sagebrush and Douglas rabbitbrush. These shrub species occur sparingly on the bald type and are usually of very low growth form.

The diverse (31 species) herbaceous stratum consists of low grass and forb species that form a carpet-like mat that assists in reducing desiccation by strong winds. Two species, stemless goldenweed and Sandberg bluegrass, were the dominant species.

Shadscale - The shadscale type was sampled with two permanent transects. These permanent transects provide data on seasonal and annual vegetation changes for the herbaceous stratum. Shadscale ranges in elevation from 1969 to 2076 m (6,460 to 6,810 ft) and occurs in narrow bands on steep, generally south-facing slopes.

In the herbaceous stratum, ten species provided only 0.4% total cover. Whitestem mentzelia and eriogonum were the dominant species. Indian ricegrass was also frequently encountered.

Riparian - The riparian type was sampled with three permanent and two non-permanent transects. Two strata and 26 species were identified for the riparian type: 12 species in the shrub stratum and 14 species in the herbaceous stratum. The riparian type was sampled over an elevational range of 1935 to 2316 m (6,350 to 7,600 ft).

The riparian type in the study area consists of three different types of environments: small springs in open bottomlands that have been converted to pastureland, hillside springs and seeps along the bottom of steep draws, and drainageways of intermittant streams. Tree species are not frequently encountered in this type.

In the shrub stratum, 12 species contributed 35% total cover. Big sagebrush and rubber rabbitbrush were the dominant species.

In the herbaceous stratum, 14 species contributed 7% total cover. Quackgrass was the dominant species, providing 74% relative cover. Sedge and common dandelion were other frequently encountered species.

2.3.3 Small Mammals

Small mammal baseline field studies were conducted between 15 and 20 May 1976. They included live-trapping, removal trapping for analysis of reproductive effort and stomach analysis and pitfall trapping.

Live Trapping - Seven hundred fifty-three individuals, representing nine species, were captured during the May 1976 trapping session. Table 2.3-1 presents a summary of live-trapping results using the number of individuals captured per 100 trap nights (capture success) as an indicator of relative abundance. Table 2.3-2 presents the species diversity index and related parameters for each of the live-trapping grids.

Table 2.3-1. Small mammal trapping summary by species for all grids sampled during May 1976 sampling period for RBOSP.

Grid	Vegetation Type	Number of Individuals of Each Species Captured per 100 Trap Nights (CS)[1]									
		E. minimus	*E. quadrivittatus*	*S. tridecemlineatus*	*S. lateralis*	*P. apache*	*P. manicalatus*	*P. truei*	*C. gapperi*	*M. longicaudus*	Grid Total
		N[2]-CS	N-CS	N-CS	N-CS	N-CS	N-CS	N-CS	N-CS	N-CS	N-CS
1	Bottomland Meadow	0	0	0	0	0	5- 3.03	0	0	0	5- 3.03
2	Sagebrush	0	0	3-1.82	0	0	25-15.15	0	0	0	28-16.97
3	Rabbitbrush	12- 7.27	0	0	0	0	26-17.76	0	0	0	38-23.03
4	P-J/Mixed Brush	32-19.39	0	0	2-1.21	1-0.61	15- 9.09	0	0	0	50-30.30
5	Mixed Brush	31-18.79	0	0	0	0	9- 5.45	0	0	0	40-24.24
6	P-J/Sagebrush	13- 7.88	0	0	1-0.6	0	27-16.36	0	0	0	41-24.85
7	Upland Meadow	0	0	0	0	0	20-12.12	0	0	0	20-12.12
A	Greasewood-Sagebrush	35- 5.26	0	0	1-0.15	1-0.15	59- 8.87	0	0	1-0.15	97-14.59
B	Pinyon-Juniper (S)	24- 3.61	10-2.21	0	12-1.80	3-0.45	33- 4.96	6-0.90	0	0	96-14.44
C	Pinyon-Juniper (N)	15- 2.25	6-0.90	0	8-1.20	2-0.30	63- 9.47	0	0	0	94-14.13
D	Sagebrush	21- 3.16	0	0	14-2.10	0	51- 7.67	1-0.15	0	0	87-13.08
E	Mixed Brush	22- 3.31	0	0	1-0.15	0	70-10.53	0	0	1-0.15	94-14.13
F	Douglas Fir	3- 0.98	0	0	0	0	11- 3.61	0	10-3.28	0	24- 7.87
G	Aspen	3- 0.98	0	0	0	0	25- 8.19	0	10-3.28	1-0.33	39-12.79
Species Total[3]		211- 4.14	24-0.47	3-0.06	39-0.77	7-0.13	439- 8.62	7-0.13	20-0.39	3-0.06	753-14.79 (GRAND TOTAL)[4]

[1] (CS) Capture success, derived from the number of individuals captured per 100 trap nights; one trap set for 24 hours is one trap night.

[2] N - Number of observations (i.e., number of individuals captured).

[3] Species total - Capture success (CS) based on the total numbers of individuals captured of species i, per the total number of trap nights set for all grids; CS figure is converted to 100 trap nights form.

[4] Grand Total - Total number of all species per total number of trap nights for all grids, converted to 100 trap nights form.

variance of H' (var (H')), maximum expected value of H' (H' (max)), and equitability (J) for all small mammal grids during sample period 7, May 16-20, 1976, for RBOSP

Grid Designation	Vegetation Type	N[1]	H'	E(H')	var(H')	H'(max)	J
1	Bottomland meadow	1	0.0	0.0	0.0	0.0	0.0
2	Sagebrush	2	0.340	0.491	0.016	0.693	0.491
3	Rabbitbrush	2	0.624	0.122	0.004	0.693	0.900
4	P-J/mixed brush	4	0.854	0.293	0.012	1.386	0.616
5	Mixed brush	2	0.533	0.769	0.007	0.693	0.769
6	P-J/sagebrush	3	0.730	0.664	0.009	1.099	0.664
7	Upland meadow	1	0.0	0.0	0.0	0.0	0.0
A	Greasewood-sagebrush	5	0.812	0.504	0.006	1.609	0.505
B	Pinyon-juniper (S)	6	1.569	0.876	0.004	1.792	0.875
C	Pinyon-juniper (N)	5	1.028	0.639	0.010	1.609	0.639
D	Sagebrush	4	1.001	0.722	0.005	1.386	0.722
E	Mixed brush	4	0.656	0.473	0.006	1.386	0.473
F	Douglas fir	3	0.982	0.894	0.009	1.099	0.893
G	Aspen	4	0.925	0.667	0.017	1.386	0.667

[1] N is the number of species captured

Analysis of these data show that of the seven .81 ha grids, Grid 4 (Pinyon-Juniper/Mixed Brush) yielded the greatest number of captures and produced the highest species diversity value. Grid 1 (Bottomland Meadow) exhibited the least number of captures. Only one species was captured on Grid 1 (Bottomland Meadow) and Grid 7 (Upland Meadow) yielding a zero species diversity for these grids. All of the 7.29-ha grids, Grids A through E, exhibited a similar number of captures. Species diversity values varied, however, with Grid B (Pinyon-Juniper) exhibiting the greatest diversity.

Of the two 1.35-ha grids, the greatest number of individuals was captured on Grid G (Aspen), while Grid F (Douglas-Fir) produced the highest species diversity value.

The least chipmunk was the second most abundant of all species captured during the May 1976 sampling period, comprising 28% of total captures. It was most abundant on Grids 4 and 5 (Pinyon-Juniper/Mixed Brush and Mixed Brush) and also exhibited its highest capture success on these grids.

The Colorado Chipmunk was the fourth most abundant species captured during the May 1976 sampling period, comprising 3% of total captures. This species was captured only on two grids, Grid B (Pinyon-Juniper, south slope) and Grid C (Pinyon-Juniper, north slope).

The thirteen-lined ground squirrel was captured only on Grid 2 (Sagebrush). This species was the least abundant species captured, comprising only 4% of total relative abundance.

The golden-mantled ground squirrel was the third most abundant species captured, comprising 5% of the total relative abundance. This squirrel was captured on six grids with pinyon-juniper, brush or a mixture of pinyon-juniper brush vegetation.

The apache pocket mouse was captured infrequently on four grids, Grid 4 (Pinyon-Juniper/Mixed Brush), Grid A (Greasewood-Sagebrush), Grid B (Pinyon-Juniper, south slope) and Grid C (Pinyon-Juniper, north slope). It comprised < 1% of the total relative abundance.

The deer mouse was the most abundant species captured, comprising 58% of the total relative abundance. This species was captured on all grids and was most abundant on grids with pinyon-juniper/mixed brush, mixed brush or greasewood-sagebrush vegetation. Analysis of reproductive data indicated that the deer mouse was well into its reproductive season during the May sampling period.

The piñon mouse comprised < 1% of the total relative abundance of the May 1975 sampling period. This species was captured only on two girds, Grid B (Pinyon-Juniper, south slope) and Grid D (Sagebrush).

The red-backed vole was the fifth most abundant species captured, comprising 3% of the total relative abundance. This species was captured only on two grids, Grid F (Douglas-Fir) and Grid G (Aspen).

The long-tailed vole was the least abundant of the rodent species trapped, comprising only < 1% of the total relative abundance. It was captured on three grids, Grid A (Greasewood-Sagebrush), Grid E (Mixed Brush) and Grid G (Aspen).

Capture success during the May 1976 trapping session (as indicated by the total number of individuals captured per 100 trap nights) was higher than any of the previous six trapping periods. The increase in the number of rodents in the study area reflects an increase in the number of deer mice captures, particularly juveniles during May 1976. The number of deer mice increased by 176% over captures during May of 1975. The number of other rodents, however, particularly squirrel species, was approximately the same as the May 1975 sampling.

Removal Trapping - Twenty-two least chipmunks (8 males, 13 females and one sex unknown), 48 deer mice (29 males and 19 females) and 1 long-tailed vole (one male) were captured and removed for analysis of reproductive effort and/or stomach contents during the May 1976 sampling period. Trapping was conducted in greasewood-sage (yielding 5 least chipmunks and 14 deer mice), pinyon-juniper, south slope (yielding 5 least chipmunks and 5 deer mice), pinyon-juniper, north slope (yielding 3 least chipmunks and 11 deer mice) and aspen (yielding 3 least chipmunks, 7 deer mice and 1 long-tailed vole) vegetation types.

Ten female least chipmunks were analyzed for reproductive effort. Three of the ten were found to be pregnant, one with five embryos, the other two with six each. Live-trapping reproductive data indicated that this species was at the start of its reproductive season during the May sampling period. However, the low number of captures precludes analysis of reproductive status and reproductive effort at this time.

Nine least chipmunks were dissected and stomach contents analyzed for seed, plant tissue, and insect food particles. The overall dietary composition of the least chipmunk was 32% seeds, 60% plant matter and 8% insect.

Sixteen female deer mice were dissected and analyzed for reproductive effort. Of the 16, only 3 were found to be pregnant. One female possessed five embryos while two females possessed six each. One of the females with the six embryos was on her second litter of this reproductive season (as determined by examination of placental scars). This second litter supports the contention (derived by analysis of live-trapping reproductive data) that the deer mouse was well into its reproductive season during the May 1976 sampling session.

Nineteen deer mice were dissected and stomach contents analyzed for seed, plant tissue and insect food particle remains. Overall, the diet of the deer mouse during the May 1976 sampling period consisted of 51% seed, 38% plant and 12% insect material.

The dietary composition of the one male long-tailed vole taken in aspen vegetation was 36% seeds and 64% other plant materials.

Pitfall Trapping - The pitfall trapping program is designed to sample all defined habitats in order to document the presence of "trap shy" small mammals (e.g., shrews). Fifteen pitfall sets, one near each small mammal grid and one in riparian habitat, were operated during the May 1976 sampling period. No new species were caught during this sampling period. Thirteen deer mice (2 adult males, 5 juvenile males and 6 sex undetermined juveniles) and one yet to be identified vole species were captured in pitfall traps during the May 1976 sampling.

2.3.4 Large Mammals

Mule Deer - The maximum daily total of deer observed during aerial censusing in March and April was 790, and a maximum daily total of 364 deer were observed on migration transects during April and May. The majority of the deer was observed east of Tract C-a in the Ryan Gulch, Yellow Creek and Big Duck drainages. Some deer were observed on 84 Mesa and along Wagon Road Ridge.

Data obtained during the mule deer migration program do not represent the peak migration period. Migration probably occurs over an extended period of time, with its length affected by weather conditions. Tract C-a appears to be a Transition Zone providing food, cover and water for deer as they migrate to winter range or from winter range to summer range. Tract C-a provides an important, yet not unique, habitat for mule deer in this area. Migration studies indicate that the Piceance Basin mule deer herd associated with Tract C-a migrates along poorly-defined corridors

Feral Horses - Maximum daily total of feral horses observed during five censuses was 115. The majority of the horses was located east of the tract, with equal numbers observed on tract and to the west. The greatest number of horses was observed on Transect 14 which passes through Tract C-a.

Elk - A small group of elk was again observed in areas west of Tract C-a during the spring quarter. A total of 39 elk was observed during five aerial censuses. The largest number was recorded on 8 April 1976 on Transect 18, when 13 elk were observed. Elk utilize both the Douglas-fir-Aspen community and mixed brush communities for food and cover.

2.3.7 Avifauna

Baseline avifauna studies were continued this quarter. Quantitative and qualitative transects of songbirds, blue grouse upland gamebird surveys, waterfowl and shorebird counts and raptor aerial and ground surveys were conducted. Six new bird species were encountered this reporting quarter. This brings the total number of birds observed to date to 138 species. Of these, 56 were observed during the spring quarter (Table 2.3-3). Two species of special interest observed during this quarter were the greater sandhill crane* and the whooping crane*. The shoveler, whooping crane, hairy woodpecker, bohemian waxwing, evening grosbeak and pine grosbeak were reported for the first time since the start of the RBOSP baseline program.

Quantitative transects that were initiated during February 1976, as part of the previous reporting quarter, were interrupted due to inclement weather. Therefore, those transects were not run during February, but were run in March. Both February and March data are reported as winter data in this report. Spring transects were run as scheduled during April.

The horned lark, scrub jay, piñon jay, mountain chickadee and evening grosbeak were the most frequently encountered species during the winter census. The greatest number of species recorded for an individual transect was 11 on Transect 4 (Pinyon-Juniper/Mixed Brush). Nine species were observed on Transect 13 (Douglas-Fir), while eight or fewer species were observed on the remaining transects. Transects 7 (Upland Meadow) and 14 (Aspen) were not run during February or March as snow drifts prevented access to their locations.

The mountain bluebird, American robin, red-cross-bill, evening grosbeak and vesper sparrow were the most frequently observed species during the spring census. Twelve species were observed on Transect 6 (Pinyon-Juniper/Sagebrush), ten species on Transect 8 (Greasewood/Sagebrush) and nine species on Transects 3 (Rabbitbrush), 4 (Pinyon-Juniper/Mixed Brush) and 15 (Riparian). Seven or fewer species were observed on the remaining transects.

Qualitative transect surveys were conducted to census bird species that may not have been discovered during other bird studies. No new bird species were encountered during winter or spring qualitative transects. In addition, all bird species observed on qualitative transects were also observed

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* Discussed in endangered species section, 2.3-12.

Table 2.3-3. Bird species observed, habitat in which birds were observed and months of observation for bird species encountered during 7th quarter for RBOSP.

	Aspen	Douglas Fir	Upland Meadow	Mixed Brush low elevation	Mixed Brush high elevation	Pinyon-Juniper north slope	Pinyon-Juniper south slope	Pinyon-Juniper Mixed Brush	Pinyon-Juniper Sagebrush	Sagebrush low elevation	Sagebrush high elevation	Greasewood - Sagebrush	Rabbitbrush	Riparian	Bottomland Meadow	Aerial[1]	Comments
Mallard														A,W		A	
Green-winged Teal														W		A	
Shoveler														W			N
Golden Eagle				M												R	
Marsh Hawk																A	
American Kestrel																A	
Blue Grouse																	B
Whooping Crane															O,Y		N
Greater Sandhill Crane														O,A	O,Y		
Killdeer														FAW			
Common Snipe														F,A			
Mourning Dove									A								
Screech Owl																	C
Great Horned Owl	A																C
Pygmy Owl																	C
Long-eared Owl																	C,D
Short-eared Owl																	C
Saw-whet Owl																	C,D
Poor Will																	C

	Aspen	Douglas Fir	Upland Meadow	Mixed Brush low elevation	Mixed Brush high elevation	Pinyon-Juniper north slope	Pinyon-Juniper south slope	Pinyon-Juniper Mixed Brush	Pinyon-Juniper Sagebrush	Sagebrush low elevation	Sagebrush high elevation	Greasewood - Sagebrush	Rabbitbrush	Riparian	Bottomland Meadow	Aerial[1]	Comments
Common Flicker	A	M,A		A		M	M	M,A	A							A	
Hairy Woodpecker		M															N
Say's Phoebe									Q				A		A		
Horned Lark			A		F,A				F	M			Q		F	F,M	
Rough-winged Swallow														A			
Steller's Jay		A															
Scrub Jay				M			M	M,A	F,A				F,A	F,A		M	
Black-billed Magpie							A								F	F	
Common Raven	A		A			A			A					A		FMAR	
Piñon Jay							M,A	M	F							M,A	
Clark's Nutcracker	A	M,A				A						Q					
Black-capped Chickadee	A	M,A		M	F			M									
Mountain Chickadee	A	M				M	M	M,A	A								
White-breasted Nuthatch							A		A								
Red-breasted Nuthatch	A	M,A				M											
Rock Wren									Q			A	A				
Sage Thrasher												A					
American Robin						A	M	M,A	A		A		A	A	A		
Mountain Bluebird				M		M	M,A	M	A		A	A		A	A	M	

Table 2.3-3. (Continued)

	Aspen	Douglas Fir	Upland Meadow	Mixed Brush low elevation	Mixed Brush high elevation	Pinyon-Juniper north slope	Pinyon-Juniper south slope	Pinyon-Juniper Mixed Brush	Pinyon-Juniper Sagebrush	Sagebrush low elevation	Sagebrush high elevation	Greasewood - Sagebrush	Rabbitbrush	Riparian	Bottomland Meadow	Aerial[1]	Comments
Ruby-crowned Kinglet		M															
Bohemian Waxwing											F					F	N
Western Meadowlark											Q				A		
Red-winged Blackbird												A		F,A	A		
Evening Grosbeak					A	M	M	M	F,A		A	M				FMA	N
House Finch						M		M	A				F			A	
Pine Grosbeak		M															N
Red Crossbill		M,A			A		M		F,A		A					A	
Green-tailed Towhee				A							A	Q	A	A			
Rufous-sided Towhee			A	M				M,A									
Vesper Sparrow			A	A	A						A	A	A				
Sage Sparrow									Q	M		M	Q	Q			
Dark-eyed Junco				M	A			M,A	A			M,A	A				
Chipping Sparrow										A	A						
Brewer's Sparrow												A	A				
White-crowned Sparrow												A					
Golden-crowned Sparrow												A					
Song Sparrow												A	A	A	A		

Table 2.3-3 (Continued)

Codes

F = February
M = March
A = April
Y = May
N - New species for RBOSP baseline program
Q = Observed in qualitative transect
B = Observed on grouse transect
C = Observed on night owl transect
O = Opportunistic
R = Observed on raptor aerial census
D = First reported in 6th Quarterly Report
W = Waterfowl and shore bird counts
[1] = Species observed in flight, thus not associated with a particular habitat at time of observation

during other phases of the winter-spring RBOSP avifauna program.

Blue grouse were censused using a standard road transect on 17, 20 and 25 May 1976. The transect started on 20 May and was halted after extremely high winds made observations impossible. The transect of 25 May was resumed where the 20 May transect ended. The road transect traverses upland meadow, mixed brush, aspen and Douglas-fir vegetation types. Thirteen blue grouse were observed during the 17 May transect. Only one grouse was observed at the start of the second transect; four birds were observed at its completion.

Waterfowl and shorebird surveys were conducted on four consecutive days, 20 through 23 April 1976, at Stake Springs Pond. Four species were observed (mallard, green-winged teal, shoveler and killdeer) with the mallard being most abundant. Both the mallard and the killdeer were observed on all counts. The shoveler was observed for the first time since the start of the RBOSP terrestrial program, during the April waterfowl counts.

Two aerial censuses for raptors were conducted during the 7th reporting quarter. The first was conducted on 8 March 1976. One common raven and five golden eagles were observed during this census. The second aerial survey was conducted on 25 March 1976. Two common ravens were the only raptor-like species observed.

Two owl night road transects were conducted during the reporting quarter. The first transect commenced on 15 May 1976, but was halted halfway through as high winds made observations impossible. The transect was resumed on the following evening (16 May 1976) at the point where the previous night's transect had ended. Two short-eared owls and one saw-whet owl were observed during the first night of the transect. Two great-horned owls, one saw-whet owl and one long-eared owl were observed during the second night of the first transect. The second transect commenced on 17 May 1976, and was completed in its entirety that evening. One long-eared owl, six great-horned owls, two saw-whet owls, one short-eared owl, one screech owl and two pygmy owls were observed during the May transect. One poor will was also observed on this transect.

2.3.8 Reptiles and Amphibians

Three species of amphibians were observed during the breeding survey. They included the chorus frog, spadefoot, and tiger salamander. A total of seven individuals was recorded, including four chorus frogs, two spadefoot toads and one tiger salamander. All were observed either in Corral Gulch or Stake Springs. The surveys were conducted on 17 and 18 May 1976.

2.3.9 Invertebrates

Invertebrate samples were collected during the quarter. Identification of specimens and reduction of data are not yet complete, however. These data will be presented next quarter.

2.3.10 Domestic Livestock

Since this livestock census was conducted, during late winter - early spring, the majority of the cattle was found at lower elevations where supplementary feeding could be carried out and where weather conditions were less harsh. A total of 932 head of cattle was observed during the five censuses. Of this total, 99% were observed east of Tract C-a with the majority southeast in protected areas such as Ryan Gulch. As weather conditions become more favorable, the cattle will be moved into the tract vicinity for summer grazing.

2.3.11 Remote Sensing

Aerial photographs have been arranged in flight lines. Remote sensing analysis is underway.

2.3.12 Threatened and Endangered Species

Sandhill Crane Studies - The greater sandhill crane (*Grus canadensis tabida*) is considered by the Colorado State Wildlife Commission (1973) to be an endangered species if found nesting within the state. This status applies only to the Colorado nesting population and does not apply to birds found feeding within the state or birds found migrating through the state.

Observations of sandhill cranes in the vicinity of Calamity Ridge and Little Duck Creek (17 April 1975) and 84 Mesa (25-30 April 1975) led to the initiation of special sandhill crane studies in the spring of 1975. These studies were continued during the fall of 1975 and were resumed during this reporting quarter.

The spring 1976 sandhill crane studies were initiated on 28 March 1976 and completed on 7 May 1976. The purpose of these surveys was to determine whether the birds returned to 84 Mesa or adjacent areas during the spring migration. The spring studies involved aerial, vehicle and foot surveys. Areas surveyed included 84 Mesa, Tract C-a, Stake Springs Draw, Corral Gulch, Yellow Creek, Duck Creek, Ryan Gulch, Piceance Creek and the White River.

These surveys were performed with the cooperation of the U.S. Bureau of Sport Fisheries and Wildlife, Monte Vista Wildlife

Refuge and in conjunction with ongoing BLM sandhill crane studies (Mike Getman) within the Piceance Basin. Dr. Walt Graul (non-game bird biologist, Colorado Division of Wildlife) and Dr. Rod Drewien (Idaho Cooperative Wildlife Unit) were given tours of the Tract C-a area to aid both men in the formulation of an opinion of the status of the birds within the area.

No sandhill cranes were observed in the vicinity of Tract C-a during the spring surveys. One crane, however, was observed in the vicinity of Meeker. It appears, therefore, that 84 Mesa is not an important migratory stopover for cranes.

Opportunistic Sightings - Sandhill cranes were observed on two occasions within the 5-mile perimeter baseline study area during this reporting quarter and during other baseline activities. The first sighting was on the evening of 26 April 1976 at Stake Springs Pond. Two birds were observed feeding and preening by ECI biologists. The same two birds were observed the following morning and were last observed around 0945 hours flying northward. A storm front, which passed through the evening before, was probably the causative factor for the migrants' stopover at Stake Springs Pond.

On the morning of 3 May 1976, at 0810 hours, ECI biologists sighted four greater sandhill cranes and one whooping crane flying northeast of 84 Ranch. The birds subsequently landed in the hay meadow 2 km northeast of 84 Ranch. The birds had left the area by 1045 hours (Getman, 1976, page 22), apparently resuming their migratory flight northwest.

Getman (1976, page 22), in his report on the status of sandhill cranes in Piceance Basin, lists two other sightings in the region. The first sighting of two birds occurred during the first week of April. The birds were sighted 2 km north of the confluence of Piceance Creek and Ryan Gulch. The second sighting took place the evening of 25 April and the morning of 26 April in a hay meadow in Yellow Creek, approximately 14.5 km (9 mi) northeast of Tract C-a. The 30-40 birds seen feeding in the meadow resumed their migration on 26 April.

The whooping crane observed near 84 Ranch was the first sighting of this species, both for the RBOSP terrestrial baseline program and for northwestern Colorado. The bird sighted is one product of an international experiment presently being conducted by biologists in Canada and the United States. The overall objective of the experiment is to see whether or not a second separate flock of whooping cranes can be established by transplanting whooping crane eggs under sandhill cranes for hatching and rearing by sandhill cranes. It is hoped that this will increase the chances of survival of the whooping crane.

Whooping cranes were introduced into the Rocky Mountain population of sandhill cranes last spring. Whooping crane eggs were taken from nests in Canada and placed in sandhill crane nests at Gray's Lake, Idaho. Sandhill cranes, acting as "foster parents", raised the whooping crane chicks. The whooping crane observed near 84 Ranch is believed to be one of the four whooping cranes known to survive the first year of the transplant experiment. If the overall sandhill crane-whooping crane foster parent program proves to be a success, more sightings of whooping cranes will probably occur in northwestern Colorado.

Sighting of the whooping crane in the 84 Mesa area indicates that sandhill cranes migrate through the Piceance Basin as they fly to areas north of Colorado, and are not part of the Colorado nesting population.

2.3.15 Browse Condition and Utilization

The browse condition and utilization program is concentrating on two major vegetation types of the Tract C-a study area, pinyon-juniper and mixed brush. Sampling was conducted in late April 1976 on 100 sampling locations. These locations were predetermined by examination of phytosociological vegetation maps and consequent selection of sampling sites which supported a preponderance of the key browse species of particular interest. Key species include: juniper, pinyon, bitterbrush, serviceberry, chokecherry and snowberry.

The data collected in April 1976 are presently being analyzed for: availability, form class, age class, hedging classification and leader use estimates. Consequently, the browse condition and utilization levels of the study area can be determined and used to ascertain whether carrying capacities of current game ranges are in balance with existing deer populations. This analysis will be reported in the final report.

LITERATURE CITED

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Getman, M. 1976. Status of greater sandhill cranes in Piceance Basin. Unpublished BLM report. July 1976. 39pp.

2.4 Aquatic Studies

The overall objective for the Aquatic Baseline Data Accumulation Program is to characterize the existing aquatic communities on and in the vicinity of Tract C-a. These studies will inventory aquatic habitats which may be affected by oil shale development.

In order to fulfill these objectives, 35 sampling stations have been selected to represent the aquatic habitats present. Emphasis has been placed on Yellow Creek and the White River which are permanently flowing streams. Sampling periods discussed herein are November - December 1975 and February and April 1976. The condition (dry or flowing) of each station during this period and dates on which aquatic samples were taken during November - December 1975 and April 1976 are shown in Table 2.4-1. Physical, chemical, and biological measurements are taken concurrently at each sampling site.

2.4.1 Physical and Chemical Characteristics

During the April 1976 sampling period, a total of six sampling sites was dry or inaccessible; the dry sites were Stations 6, 10 - 12, and 16; Station 1 was inaccessible. A summary of selected parameters for the Yellow Creek and White River stations is presented below.

April 1976

Parameter	Yellow Creek	White River
Specific conductance (μmhos)	2800 -4000	600 -1400
pH	8.2- 8.7	8.0- 8.5
Alkalinity, total ($CaCO_3$ mg/l)	853 -1658	184 - 249
Chloride (mg/l)	29 - 135	26 - 43
Sulfate (mg/l)	206 - 322	46 - 69
Dissoloved solids (mg/l)	2301 -2673	426 -1041
Turbidity (JTU)	100 - 220	23 - 75
Dissolved oxygen (mg/l)	9.4- 10.8	9.7- 10.6
Temperature (°C)	11 - 19	7 - 17

The summary of selected physical and chemical data for the April sampling period reflects the spring conditions which prevailed during the sampling. Thus, turbidities and dissolved solids concentrations were generally high due to initial spring run-off.

Table 2.4.1. Dates of sampling for RBOSP Aquatic Baseline Studies, November - December 1975 and April 1976.

	November - December 1975		April 1976	
Station	Date Sampled	Flow Condition	Date Sampled	Flow Condition
1	11-06-75	Flowing	4-29-76	Inaccessible
2	11-10-75	Flowing	4-29-76	Flowing
3	11-21-75	Flowing	4-28076	Flowing
4	11-21-75	Flowing	4-27-76	Flowing
5	12-03-75	Flowing (Ice Covered)	4-09-76	Flowing
6	12-03-75	Dry	4-22-76	Dry
7	12-03-75	Flowing (Ice Covered)	4-27-76	Flowing
8	12-03-75	Flowing	4-22-76	Flowing
9	12-03-75	Flowing	4-27-76	Flowing
10	11-21-75	Dry	4-26-76	Dry
11	11-21-75	Dry	4-26-76	Dry
12	12-03-75	Frozen	4-27-76	Dry
13	12-01-75	Flowing	4-22-76	Flowing
14	12-01-75	Flowing (Ice Covered)	4-26-76	Flowing
15	12-01-75	Flowing (Ice Covered)	4-06-76	Flowing
16	12-03-75	Dry	4-06-76	Dry
17	12-01-75	Flowing	4-06-76	Flowing
18	12-01-75	Flowing	4-06-76	Flowing
19	11-25-75	Flowing (Ice Covered)	4-09-76	Flowing
20	11-24-75	Flowing (Ice Covered)	4-20-76	Flowing
21	11-24-75	Flowing (Ice Covered)	4-20-76	Flowing
22	11-24-75	Flowing (Ice Covered)	4-20-76	Flowing
23	11-24-75	Flowing (Slush)	4-16-76	Flowing
24	11-17-75	Flowing	4-12-76	Flowing
25	11-17-75	Flowing	4-12-76	Flowing
27	11-19-75	Flowing	4-15-76	Flowing
28	11-19-75	Flowing	4-15-76	Flowing
29	11-19-75	Flowing	4-15-76	Flowing
30	11-18-75	Flowing	4-13-76	Flowing
31	11-18-75	Flowing	4-13-76	Flowing
32	11-18-75	Flowing	4-13-76	Flowing
33	11-20-75	Flowing (Slush)	4-14-76	Flowing
34	11-20-75	Flowing (Slush)	4-14-76	Flowing
35	11-20-75	Flowing (Slush)	4-14-76	Flowing

Comparison of physical and chemical data from April 1976 with that from April 1975 indicates that water temperatures were slightly (1 to 5°C) warmer in 1976 in both the White River and Yellow Creek. Whereas turbidities in the White River were lower in April 1976 than during the previous year (42 - 110 JTU), they were higher in Yellow Creek (65 - 86 JTU in April 1975). The range of dissolved solids concentrations in the White River was higher in April 1976 than in April 1975 (453 - 644 mg/l), as was the range of specific conductance (630 - 850 μmhos in April 1975) primarily because of the high values recorded at Station 28 (the confluence with Yellow Creek). The range of dissolved solids in Yellow Creek was generally higher in April 1976 than during the previous April (2000 - 2500 mg/l) as was the range of specific conductance (2500 - 3700 μmhos).

The generally higher turbidity, specific conductance, and dissolved solids observed in Yellow Creek in April 1976 indicate that the spring run-off was nearer to its peak during the 1976 sampling than during the 1975 period.

2.4.2 Phytoplankton

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A total of 196 algal taxa has been observed in samples collected during April 1976. Samples analyzed to date indicate that during April the most abundant phytoplankton taxa at the headwater stations were the diatoms *Navicula pelliculosa*, *Achnanthes minutissima*, and *Surirella ovata* and the chrysophyte *Chrysidiastrum ocellatum*. Phytoplankton abundance was generally low at the headwaters during April. At the tract stations, the most abundant taxa (based on analyses completed to date) were *Navicula pelliculosa*, *Chrysidiastrum ocellatum*, and unidentified flagellates. In Yellow Creek, the dominant phytoplankton taxa included *Synedra amphicephala*, *Nitzschia capitellata*, *Surirella ovata*, and unidentified flagellates, whereas in the White River, the most abundant taxa were *Navicula viridula*, *Gomphonema olivaceum*, *Nitzschia capitellata*, and *Surirella ovata*.

Comparison of phytoplankton data from April 1976 with those from April 1975 indicates that diatoms were generally the most abundant algal taxa in the phytoplankton of the study area during both years. Phytoplankton abundance was generally low throughout the study area and phytoplankton constitutes a secondary source of primary production (periphytic algae is the primary source) in waters of the area.

2.4.3 Zooplankton

Protozoa of the genus *Centropyxis* dominated the zooplankton of all stations in November - December 1975. The rotifer fauna was dominated by bdelloid species at the spring brook stations, by *Notholca* species at Station 14, and the lower Yellow Creek Stations, and by monogonont rotifers in the White River. The Crustacea fauna was scarce in November 1975 with only *Bryocamptus hiemalis* common at the spring brook stations and *Eucyclops agilis* found in the Yellow Creek stations.

Centropyxis species again dominated the Protozoa fauna at the h and tract stations in April 1976. However, sessile ciliates, i Epistylis and Vorticella species occurred in high densities at 14 and also the White River. Bdelloid rotifers were the most a component of the rotifer fauna at most stations other than thos the White River. At Station 14, however, high densities of Not species and several other loricated mongonont rotifers and hig counts of bdelloids were found. The rotifer fauna of the White River was characterized by a high diversity of monogonont rotif all of which had occurred previously in this study. Few Crusta found in April; only Bryocamptus hiemalis and ostracods abundan then only at the spring brook stations.

In general, zooplankton densities indicate that zooplankton pla lesser role as secondary consumers in the aquatic habitats on o near Tract C-a than do benthic invertebrates.

2.4.4 Periphyton

A total of 97 algal taxa was observed in the April 1976 periphy lections. Periphytic algal densities were low at the headwater during April, except at Station 5. The most abundant algal tax headwaters included Bicoeca lacustris, Navicula pelliculosa, Ac minutissima, and Gomphonema intricatum (which was particularly at Station 5). At the tract stations, the most abundant algal were Bicoeca lacustris, Gomphonema intricatum, Meridion circula Navicula pelliculosa, and Achnanthes minutissima (particularly dant at Station 8). In Yellow Creek, Navicula pelliculosa, Syn amphicephala, and Surirella ovata were the most abundant periph algal taxa, whereas in the White River, Navicula cryptocephala, Navicula viridula, Gomphonema olivaceum, Ephithemia sorex, and Nitzschia dissipata were the dominant taxa.

During April 1976, as in April 1975, diatoms were the dominant taxa in the periphyton although there were some differences in species composition of the dominant taxa. In waters of the stu the periphytic algae generally constitute the major source of p production with phytoplankton as a secondary source (since the plankton of these waters is generally derived from the periphyt

2.4.5 Benthos

Benthos taxa observed to date (laboratory analyses of Chironomi and Oligochaeta are currently being completed) from the April 1 sampling are listed in Table 2.4-2.

During the April 1976 sampling period, the most abundant benthi taxa at the headwater stations included Baetidae, Baetis, Chiro dae, and Ophiogomphus severus. The most abundant taxa at the t stations included Ophiogomphus severus, Chironomidae, and Oligo In Yellow Creek, the most abundant taxa were Oligochaeta, Chiro

Table 2.4-2. Macroinvertebrate taxa observed during RBOSP Aquatic Baseline Studies, April 1976.

- Platyhelminthes
  - Turbellaria
    - Tricladida
      - Planariidae

- Nematoda

- Mollusca
  - Gastropoda
    - Basommatophora
      - Physidae
        - *Physa* Draparnaud
      - Lymnaeidae
        - *Lymnaea* Lamark

- Annelida
  - Hirudinea
    - Rhynchobdellida
      - Glossiphoniidae
        - *Helobdella stagnalis* (Linnaeus)
  - Oligochaeta

- Arthropodea
  - Arachnoida
    - Acari
  - Crustacea
    - Amphipoda
      - Talitridae
        - *Hyallela azteca* (Saussure)
  - Insecta
    - Collembola
    - Ephemeroptera
    - Heptageniidae
      - *Heptagenia* Walsh
      - *Rhithrogena* Eaton
    - Baetidae
      - *Baetis* Leach
    - Ephemerellidae
      - *Ephemerella* Walsh
    - Tricorythidae
      - *Tricorythodes* Ulmer
    - Caenidae
      - *Caenis* Stephens
    - Leptophlebiidae
  - Odonata
    - Coenagrionidae

Table 2.4-2. (Continued)

- *Coenagrion* (Fabricius)
- Gomphidae
  - *Ophiogomphus severus* Hagen
- Plecoptera
  - Perlodidae
    - *Isoperla* Banks
    - *Isogenus* Newman
    - *Isogenoides* Klapalek
- Coleoptera
  - Haliplidae
    - *Peltodytes* Regimbart
  - Dytiscidae
    - *Deronectes* Sharp
  - Hydrophilidae
  - Elmidae
    - *Dubiraphia* Sanderson
    - *Microcylloepus* Hinton
    - *Optioservus* Sanderson
    - *Zaitzevia* Champion
  - Dryopidae
    - *Helichus* Erichson
- Trichoptera
  - Hydropsychidae
    - *Hydropsyche* Pictet
  - Hydroptilidae
    - *Mayatrichia* Mosely
  - Limnephilidae
    - *Grammotaulius* Kolenati
    - *Hesperophylax* Banks
  - Leptoceridae
    - *Oecetis* McLachlan
- Lepidoptera
  - Pyralidae
- Diptera
  - Tipulidae
    - *Ormosia* Rondani
    - *Dicranota* Zetterstedt
    - *Limnophila* Macquart
    - *Holorusia* Loew
  - Ceratopogonidae
  - Chironomidae
  - Simuliidae
    - *Simulium* Latreille
  - Stratiomyiidae
    - *Euparyphus* Gerstaecker
  - Tabanidae
    - *Chrysops* Meigen
  - Rhagionidae
    - *Atherix variegata* Walker

Table 2.4-2. (Continued)

Empididae
Anthomyiidae
  Limnophora aequifrons Stein

Simuliidae. In the White River, Ephemerella, Oligochaeta, and Chironomidae were the dominant taxa.

Preliminary comparison of the April 1976 benthos data with those of April 1975 suggest that the composition of the dominant benthic taxa in the study area was generally similar from year to year. Chironomidae and Oligochaeta were abundant in all of the sampling areas. During both sampling periods, benthic macroinvertebrates were the dominant organisms at the primary and secondary consumer levels in waters of the study area.

2.4.6 Sediment Chemistry

A summary of results for selected parameters for the April 1976 sampling is presented below. Concentrations of the parameters were generally similar to those observed during the fall of 1975.

April 1976

Parameter (µg/g)	White River	Yellow Creek
Aluminum	3000 - 13000	7300 - 12000
Arsenic	3 - 5	4 - 6
Lead	8 - 12	9 - 12
Zinc	25 - 52	27 - 53

Comparison of the April 1976 ranges of concentration for these parameters with the ranges observed in April 1975, indicate that during April 1975 greater concentrations of aluminum (6,900 - 20,400 µg/g) and zinc 50 - 110 µg/g) were observed in the White River and greater concentration of aluminum (4,200 - 24,050 µg/g) was observed in Yellow Creek than during April 1976. The ranges of concentration for other consittuents were similar during the two April sampling periods.

2.4.7 Macrophytes

During the April 1976 sampling period, no aquatic macrophytes were observed. This absence of aquatic macrophytes is likely due to the fact that sampling occurred very early in the growing season.

2.4.8 Fish

A summary of fish data from the April 1976 sampling is presented in Table 2.4-3. During the April 1976 sampling, a total of 65 fish representing eight species was captured in Yellow Creek and the White River. The most abundant species was flannelmouth sucker, and only one game fish species, mountain whitefish, was observed. The small number of fish caught can be attributed to the high flows and high turbidities encountered during the April 1976 sampling.

Table 2.4-3. List of fish species and numbers captured, White River and Lower Yellow Creek, RBOSP Aquatic Baseline Studies, April 1976.

Common Name	Scientific Name	Number Captured
Mountain whitefish	*Prosopium williamsoni*	9
Flannelmouth sucker	*Catostomus latipinnis*	37
Bluehead sucker	*Catostomus discobolus*	3
Roundtail chub	*Gila robusta*	1
Speckled dace	*Rhinichthys osculus*	10
Fathead minnow	*Pimephales promelas*	1
Mottled sculpin	*Cottus bairdi*	3
Red Shiner	*Notropis lutrensis*	1

Such high flows and turbidities generally reduce the efficiency of fishing efforts.

2.4.9 Springs and Seepages

Approximate locations of springs and seepages on or near Tract C-a are shown on Figure 2.4-1. No additional springs or seepages have been observed since Progress Report 6.

2.4.10 Hydrology

The approximate stream velocities observed during April 1976 are presented in Table 2.4-4.

Stream velocities in April 1976 are generally similar to those observed in April 1975 although some variations were observed at certain sampling sites. Stream velocities in waters of the area have been observed to vary both seasonally and geographically.

2.4.11 Miscellaneous Studies

Water quality data from the February 1976 sampling are presented in Table 2.4-5.

During February 1976, concentrations of parameters included in the water quality studies of the White River were within both the maximum allowable and the recommended limiting concentrations for chemical parameters in drinking water (U.S. Public Health Service, 1962).

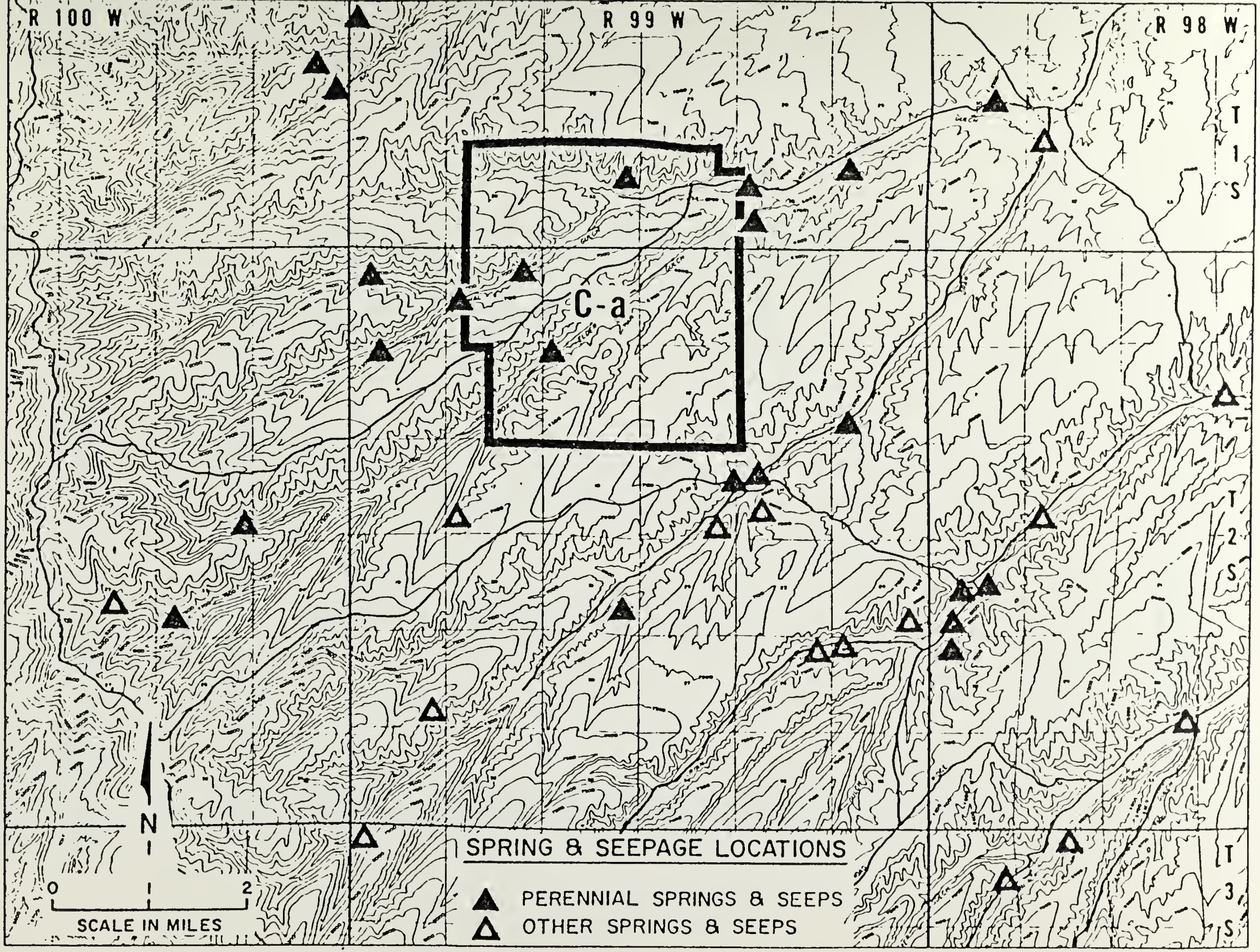

Figure 2.4-1. Spring and Seepage Locations

Table 2.4-4. Stream Flow, RBOSP Aquatic Baseline Studies, April 1976.[1] (Results are expressed in feet per second and, where appropriate, are given for bank sides (s) and point of maximum flow (m).)

Station	Flow[2] (ft/sec)		
	s	m	s
2		1.0	
3		0.7	
4		0.8	
5		1.2	
7		1.5	
8		0.9	
9		1.4	
13		1.4	
14		1.2	
15		0.3	
17		0.4	
18		0.8	
19		2.8	
20		1.1	
21		0.9	
22		0.8	
23	2.2;	2.5;	2.3
24	2.5;	1.4;	2.2
25	2.9;	2.5;	2.5
26	1.0;	2.0;	1.7
27	1.2;	1.0;	0.7
28	2.6;	1.5;	1.5
29	2.8;	3.9;	1.9
30	2.1;	2.3;	1.2
31	2.3;	2.7;	2.1
32	1.3;	2.1;	2.4
33	1.6;	2.1;	1.4
34	2.1;	2.7;	2.3
35	1.5;	3.9;	4.0

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[1] Stations 1, 6, 10-12, and 16 were dry or inaccessible at the time of sampling.

[2] Measurements taken at bank sides (s) and point of maximum flow (m) where appropriate.

Table 2.4-5. Water quality data, RBOSP Aquatic Baseline Studies, February, 1976. (Data are expressed in mg/l unless otherwise noted.)

PARAMETER	STATION REPLICATE			
	25		34	
	A	B	A	B
Arsenic (As), Diss	< 0.01	< 0.01	< 0.01	< 0.01
Barium (Ba), Diss	< 0.1	< 0.1	< 0.1	< 0.1
Boron (Bo), Diss	< 0.5	< 0.5	< 0.5	< 0.5
Cadmium (Cd), Diss	< 0.01	< 0.01	< 0.01	< 0.01
Carbon (C), Organic	1	< 1	10	2
Carbon (C), Organic Diss	1	1	2	2
Carbon (C), Organic Suspended	< 1	< 1	8	< 1
Chemical Oxygen Demand (O_2)	11	11	11	11
Chromium (Cr), Total Diss	< 0.03	< 0.03	< 0.03	< 0.03
Copper (Cu), Diss	< 0.02	< 0.02	< 0.02	< 0.02
Cyanide (Cn), Total	< 0.001	< 0.001	< 0.001	< 0.001
Fluoride (F), Diss	0.14	0.16	0.14	0.14
Iron (Fe), Total Diss	0.02	0.03	0.03	0.03
Lead (Pb), Diss	< 0.05	< 0.05	< 0.05	< 0.05
Lithium (Li), Diss	0.04	0.04	0.03	0.03
Manganese (Mn), Diss	< 0.02	< 0.02	< 0.02	< 0.02
Mercury (Hg), Diss (µg/l)	< 0.2	< 0.2	< 0.2	< 0.2
Nitrogen (N), Organic	0.37	0.35	0.38	0.44
Phosphorus (P), Total Diss	0.04	0.04	0.07	0.05
Phenolic compounds (Phenol)	0.006	0.011	0.008	0.008
Selenium (Se), Diss	< 0.01	< 0.01	< 0.01	< 0.01
Solvent extract (Oil)	0.54	< 0.003	< 0.003	< 0.003
Sulfate (S), Diss	54	53	53	53
Sulfide (S), Diss	< 0.02	< 0.02	< 0.02	< 0.02
Sulfur (S), Organic	< 1	< 1	< 1	< 1
Zinc (Zn), Diss	0.04	< 0.02	0.05	0.03

Diss = Dissolved

LITERATURE CITED

Rio Blanco Oil Shale Project, 1976. Progress Report 2, Aquatic Studies. Gulf Oil Corporation and Standard Oil (Indiana). Denver, Colorado.

United States Public Health Service. 1962. Drinking water standards. Public Health Service Publication 986. 61 pp.

2.5 Other Environmental Programs

2.5.1 Soils Survey and Productivity Assessment Studies

2.5.1.1 Objectives

The surface and subsurface soils studies are designed to fulfill the requirements of the oil shale lease, provide data necessary in the determination of ecosystem relationships and provide information required for designing a successful revegetation plan of disturbed areas.

Soil survey and productivity assessment studies are divided into three distinct projects: 1) a preliminary survey of soils of Tract C-a and vicinity and preparation of a soils map (this portion of the soils studies has been completed and is discussed in the RBOSP Annual Report, 1976), 2) drilling for surface and subsurface soils (this portion of the study has been completed and a preliminary discussion of the data is included in this report) and 3) an intensive study program of surface soils of Tract C-a and vicinity (this program is about 65% complete).

Consult previous progress reports for a more complete description of objectives of the soil program.

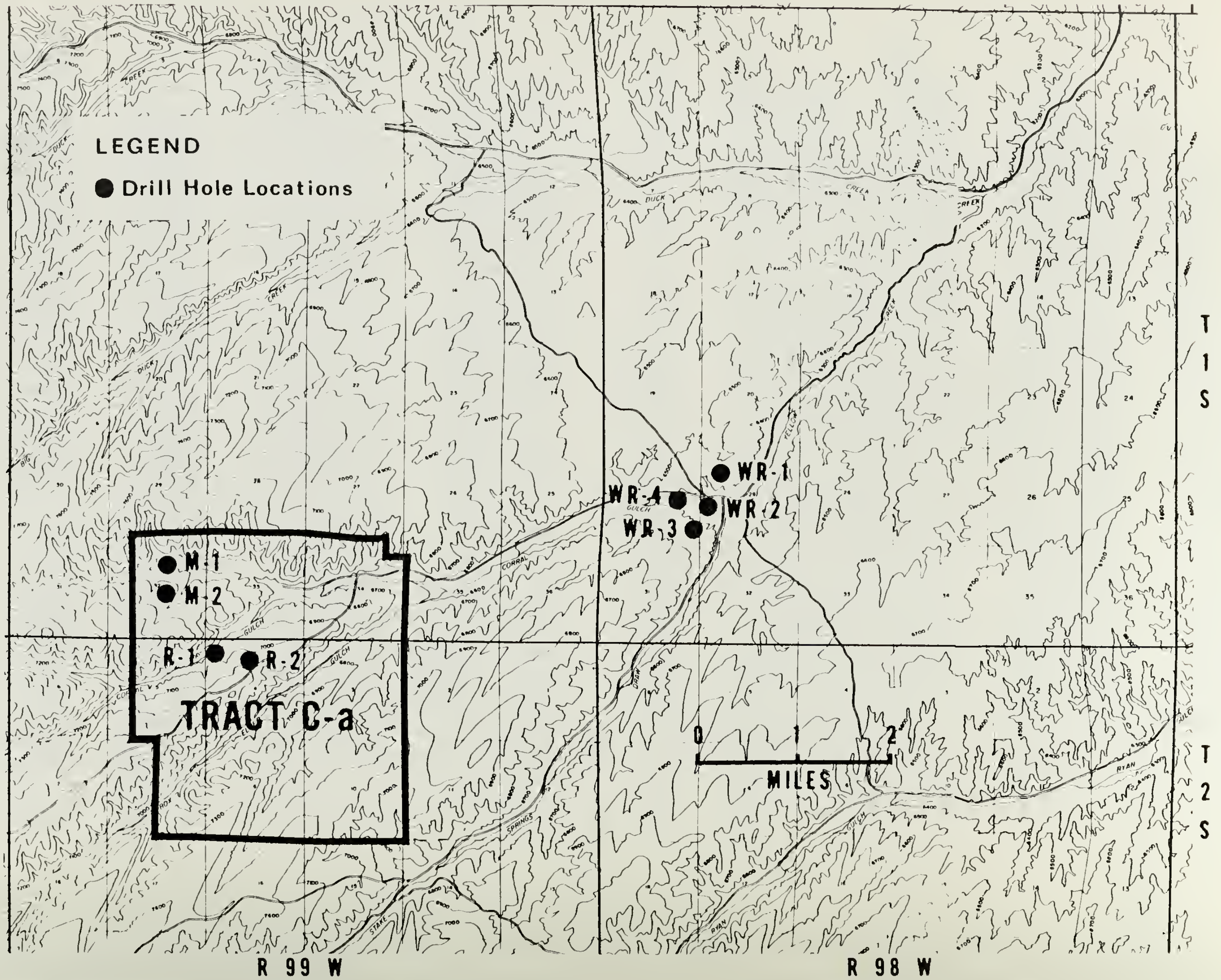
2.5.1.2 Methods

Two methods were used to collect surface soil samples. One method consisted of sampling soils from the face of a soil sampling pit. A trench 45 cm (18 in) wide, 1.5 m (5 ft) long and 1.5 m deep was dug at each sampling site. A 1500-g soil sample was taken at four depths throughout the upper 1.5 m of the soil profile.

The second method, compatible with the method used for subsurface soil sampling, employed the use of a 5-cm (2-in) diameter split spoon sampler. Composite surface soil samples were collected from the surface to 140 cm (4.5 ft) at 45-cm (1.5 ft) increments. This method was used to obtain comparative data on surface and subsurface soils.

Subsurface soils, soils below 1.4 m, were also collected with a 5-cm diameter split spoon sampler. Forty-five centimeter composite soil samples were taken at 3 to 4.5-m intervals from a depth of 1.4 m to bedrock.

Drilling for surface and subsurface soil samples was done with a CME-75 truck-mounted drill. Soil samples were taken with a 5-cm diameter split spoon. Drilling site locations are presented in Figure 2.5.1-1.


LEGEND
● Drill Hole Locations
WR-1
WR-2
WR-3
WR-4
M-1
M-2
R-1
R-2
TRACT C-a
0
1
2
MILES
T 1 S
T 2 S
R 99 W
R 98 W
DUCK
CREEK
YELLOW
CORRAL
GULCH
STAKE
SPRINGS
RYAN
BIG

Further discussions of methods used in soils sampling may be found in previous progress reports. A detailed description of chemical analysis methodology will be presented in the final report.

2.5.1.3 Results and Discussion

The preliminary soils map of Tract C-a, prepared by the SCS, is undergoing further revisions. A general description of the soil series, soil associations and rock outcrops encountered during surveying and mapping by the SCS are discussed in the RBOSP Annual Report, 1976.

Drilling for surface and subsurface soils samples using the 5 cm split spoon sampler has been completed. A summary of the results of the chemical and radiological analyses on surface and subsurface soils collected by the split spoon sampling technique are presented in Table 2.5.1-1.

Approximately 65% of the field work of the surface soils sampling program has been completed, with field work completed on Tract C-a and Colorado Division of Wildlife land in the vicinity of Tract C-a. Chemical and physical analyses of these soils samples have been partially completed. Completion of the remaining portion of the field work on soils in the vicinity of the tract was delayed until receipt of a special land use permit from the Bureau of Land Management. The permit has now been received and the remaining locations will be sampled during the eighth quarter of study.

The depth of soil to bedrock on tract is quite variable and averages 3 m (∿ 10 ft) on the slope to 7.5 m (∿ 25 ft) in the valley bottoms. These soils are composed of a mixture of sandy silt, sandy clay and gravelly clay. Surface and subsurface soils are slightly basic (average pH of 8.4 to 8.5). Organic matter content of these soils is moderate to low in both surface (2.57%) and subsurface (1.94%) soils, with the maximum levels of organic matter (5%) in the surface 45 cm of soil. Cation exchange capacity (CEC) for soils of this semi-arid region is normal, with the CEC of surface soils (CEC = 27.1) slightly higher than subsurface soils (CEC = 22.7). There are essentially no chemical differences between surface and subsurface soils on tract (Table 2.5.1-1). Results of chemical analyses of on-tract soils reveal that only traces of potentially toxic elements occur in the surface and subsurface soils. Of the elements analyzed, only chromium (total chromium ≈ 45 to 50 ppm) is close to potentially toxic levels (Pratt 1966). Conversely, both surface and subsurface soils are slightly deficient in several of the macro and micronutrients (e.g., nitrogen, phosphorous, manganese, iron, zinc, molybdenum).

Table 2.5.1-1. Summary of preliminary chemical and radiological data[1] of surface (0 to 1.4 m) and subsurface (1.4 m to bedrock) soils of Tract C-a and water reservoir site. Mean ($\bar{x}$) and standard deviation (SD) values are in μg/g (ppm) unless otherwise noted; n = sample size.

	ON-TRACT		WATER RESERVOIR	
	Surface	Subsurface	Surface	Subsurface
	$\bar{x}$(SD,n)	$\bar{x}$(SD,n)	$\bar{x}$(SD,n)	$\bar{x}$(SD,n)
Ammonium	27(7,11)	26(6,20)	21(9,10)	31(9,17)
Nitrate	10.5(7.7,11)	8.5(5.7,19)	24.2(37.7,10)	7.6(4.1,16)
Molybdenum				
Anion Exchangeable	.27(.27,11)	<.30(.22,20)	.34(.33,10)	1.51(4.44,17)
Gypsum (MEQ/100g)	-0-	-0-	.15(.4,10)	.1(.3,17)
Lime				
(lbs. CaCO$_3$/Acre)	-0-	-0-	-0-	-0-
Selenium Available				
(ppb)	42(38,12)	35(42,20)	27(17,10)	60(75,17)
Phosphorous				
Total	658(167,12)	673(82,20)	526(128,10)	566(89,17)
NaHCO$_2$ Extractable	10(6,12)	10(3,20)	9(8,10)	12(7,17)
Organic Matter (%)	2.57(1.11,12)	1.94(.66,20)	2.36(1.73,10)	1.14(1.25,17)
pH				
In Water	8.5(.3,12)	8.4(.2,20)	8.4(.3,10)	8.5(.4,17)
In 0.01M CaCl$_2$	8.1(.2,12)	8.2(.3,20)	8.1(.1,10)	8.2(.4,17)
Soluble Salt (mmhos/cm)				
Elec. Conductivity	1.39(1.86,12)	1.49(2.36,20)	.39(.12,10)	.52(.23,17)
Sodium				
Exchangeable (%)	11.3(12.1,12)	7.8(5.7,20)	5.6(4.5,10)	7.2(5.2,17)
Water Soluble (MEQ/100g)	1.81(2.60,12)	1.55(2.50,20)	.39(.24,10)	.65(.46,17)
NH$_4$ Acetate Soluble (MEQ/100g)	4.79(5.44,12)	3.33(3.87,20)	1.85(1.15,10)	2.22(1.44,17)
Cation Exchange				
Capacity (MEQ/100g)	27.1(4.5,12)	22.7(3.3,20)	28.4(6.7,10)	23.4(4.8,17)
Total				
Arsenic	8(4,12)	8(2,20)	4(2,10)	3(2,17)
Cadmium	<0.5	<0.5	<0.5	<0.5
Chloride (%)	.22(.07,12)	.20(.05,20)	.18(.07,10)	.20(.08,17)
Chromium	41(2,12)	40(4,20)	47(4,10)	52(11,17)
Cobalt	6(.5,12)	6(1,20)	6(.5,10)	7(1,17)
Fluoride	407(154,12)	374(99,20)	307(70,10)	256(120,17)
Mercury (ppb)	26(9,12)	28(9,20)	20(8,10)	23(12,17)
Antimony	<1	<1	<1	<1
Vanadium	68(25,12)	59(10,20)	52(10,10)	52(7,17)

Table 2.5.1-1 (Continued)

	ON-TRACT		WATER RESERVOIR	
	Surface	Subsurface	Surface	Subsurface
	$\bar{x}$(SD,n)	$\bar{x}$(SD,n)	$\bar{x}$(SD,n)	$\bar{x}$(SD,n)
Water Soluble				
Magnesium	58(92,12)	90(156,20)	21(18,10)	37(34,17)
Calcium	67(33,12)	120(205,20)	62(26,10)	50(41,17)
Potassium	36(38,12)	21(15,20)	15(8,10)	16(11,17)
Boron	1.2(.5,12)	< .8(.5,20)	< .8(.3,10)	< .8(.4,17)
Sulfate	707(1354,12)	984(1882,20)	94(74,10)	205(189,17)
DTPA Extractable				
Copper	2.1(.8,12)	2.8(.8,20)	2.2(1.9,10)	2.6(2.6,17)
Manganese	42(11,12)	28(10,20)	53(26,10)	38(22,17)
Iron	117(45,12)	122(32,20)	139(48,10)	148(47,17)
Zinc	1.1(.4,12)	1.2(.3,20)	1.0(.4,10)	1.1(.7,17)
NH_4 Acetate Extractable				
Nickel	1.0(.2,12)	.9(.2,20)	1.0(.2,10)	.9(.2,17)
Lead	.5(.1,12)	.4(.1,20)	.3(.1,10)	.3(.2,17)
Potassium	341(267,12)	167(48,20)	199(140,10)	167(152,17)
Background Radioactivity				
Uranium	3(.9,12)	4(1,20)	4(1,10)	3(2,17)
Equivalent Uranium	3(.5,11)	3(1,20)	3(1,10)	3(1,17)
Equivalent Thorium	8(3,11)	9(2,20)	11(3,10)	12(3,17)
Radium^{266} (Picocuries per g)	1.1(.2,11)	1.1(.3,20)	1.0(.4,10)	1.1(.2,17)
Potassium (%)	2.3(.3,11)	2.5(.2,20)	2.6(.3,10)	2.6(.2,17)

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[1] Samples collected with a 5-cm diameter split spoon from four drilling sites on Tract C-a and four sites in proposed water quality control reservoir area.

The alluvium in the proposed water quality control dam site in Corral Gulch is up to 23 m (∿ 75 ft) deep in the main channel and is composed of sandy silt, sandy clay and silty sand. Soils from the water reservoir area do not differ in chemical composition from soils on tract.

Permeability of the surface and subsurface soil waste dump material will be high initially but will decrease with depth as the height of the disposal pile is increased. Two factors will contribute to the decrease in permeability with depth of the disposal pile: 1) the waste material at the bottom of the dump will be the soil and partly decomposed sandstone, mudstone and marlstone from the mine surface with a high percentage of fines and sand produced in mining, hauling and dumping and 2) as the load of waste material increases on the material nearer the bottom of the dump, compaction and some consolidation will take place, reducing porosity.

It is recommended that any reclamation practice of spoil piles, whether topped off with surface or subsurface soils, include the addition of certain soil amendments such as organic matter (mulch) and fertilizers containing at least the macronutrients. Although concentrations of certain micronutrients in the soil may be slightly low, it is not recommended at this time that these elements be included in reclamation fertilization programs.

Soils from the water reservoir area do not differ in chemical composition from soils on tract and may be utilized as needed for reclamation. Since the water reservoir area does not contain toxic levels of elements, leaching losses of elements to surface water or groundwater systems should pose no threat to the environment.

LITERATURE CITED

Pratt, Parker F. 1966. Chromium. Pages 136-141 in Homer D. Chapman, ed. Diagnostic Criteria for Plants and Soils. Quality Printing Company, Inc., Abilene, TX.

2.5.2 Archaeological Survey

The final report (Olson et al., 1976) on the historical and archaeological resources of Tract C-a and vicinity was released in May 1976. This report summarized all the findings derived from the survey and artifact collections since the initial field survey in the summer of 1975; presented a literature review of the cultural history of the area; and included descriptions and photos of artifacts recovered from the area, their significance to the cultural setting and the extent of concentrations (clusters) of artifacts and sites.

Final assessment of information available provides a reasonably complete picture of aboriginal utilization of the Basin. The data suggest that the area was not utilized during winter months, but that it was used extensively during the more favorable months of the year. Camp sites were apparently chosen because of proximity to water and food, seasonal variations in climate, or perhaps personal preference. Locations and concentrations of sites suggest multiple use of the area by both sexes, with males involved in hunting (deer and small game) and women in gathering and processing of plant foods (pinyon nuts, grass seeds, etc.).

Early cultures represented by artifacts recovered during the survey include Fremont (perhaps from 400 A.D. to 1,350 A.D.), and Ute (from ? to 1881).

Historic occupation of the area by Anglos pre-dates Ute disappearance and continues to the present. Historic Anglo utilization has centered around ranching, with extensive sheep and cattle grazing. Anglo influence is represented by horse traps, corrals and cabins throughout the area, some of which are still in use.

Extensive recent use of the area by deer hunters is evidenced by modern-day deer blinds, camp sites and refuse.

The Ryan Gulch School, several miles off tract has been designated a historic landmark by the Rio Blanco County Historical Society.

Other evidence of early Anglo occupation is found in the old 84 Ranch to the east of the tract. Unfortunately, it has been largely destroyed, and much of its historic significance has been lost.

The number of artifacts recovered from the area in combination with the pattern of artifact locations indicate that some of the sites might possibly contribute to knowledge of the pre-history of the region. Therefore, sites associated with important site clusters were recommended for nomination to the National Register of Historic Places. Four site clusters were identified. Three of these clusters were considered important and all primary and secondary sites within their boundaries were recommended for nomination.

Additionally, five primary sites outside the confines of a site cluster, but within the proposed development area, were recommended for mitigation, first by avoidance, if possible or by other measures if necessary. Seven secondary sites were recognized as potentially important and were recommended for limited testing prior to disturbance to determine ultimate importance of the site.

One historic site, a horse trap, was recommended for nomination to the Register.

Prior to the 1975 survey discussed herein, Dr. Calvin Jennings, Colorado State University, conducted an archaeological survey in the Piceance Basin. He reported four sites in the vicinity of Tract C-a to be of National Register significance. Subsequent to his early reports, one of the sites, 84 Ranch, has been largely destroyed. Therefore, Dr. Jennings no longer considers the 84 Ranch site important (Calvin Jennings, personal communication). He does, however, retain the belief that the other three sites originally considered of Register significance should be nominated to the National Register of Historic Places. Dr. Jennings is currently preparing a statement of importance on these three sites to be filed with proper state and federal agencies. Upon release of this statement, Dr. Jennings' recommendations will be considered for inclusion into the Tract C-a final archaeological report.

Currently, the final report on the RBOSP archaeological survey and assessment is being reviewed by the Bureau of Land Management (BLM), the Area Oil Shale Supervisor (AOSS) and the State Historic Preservation Office (SHPO). Pending their approval of the final report, measures will be taken to assure compliance with the National Historic Preservation Act of 1966 and Executive Order 11593. Sites considered eligible to the National Register will be identified, nominations will be initiated and mitigation measures appropriate to the proposed development (a 106/2(b) statement) filed by the BLM in cooperation with the AOSS and the SHPO. The 106/2(b) statement and comments made by the SHPO will then be forwarded to the Advisory Council on Historic Preservation for review and comment.

Suggested mitigation measures for historic sites will ultimately become a part of the "conditions of approval" for the DDP.

Literature Cited

Olson, A.P., T.G. Bridge, C. Craig, B. LaFree, and S. Steenrod. 1976. An archaeological survey assessment for Rio Blanco Oil Shale Project 1975. Univ. of Denver. 136p.

2.5.8 Paleontological Survey

Results of initial paleontological studies were reported in Progress Report 5-Summary. The following information updates that report with additional data compiled within this quarter.

2.5.8.1 Objective

The objective of this program is to estimate the potential for a significant paleontological discovery within or adjacent to Tract C-a during tract development. A significant discovery is here defined as one which is unique to the area or one in which an unusually large concentration of well-preserved fossils is located.

2.5.8.2 Methods

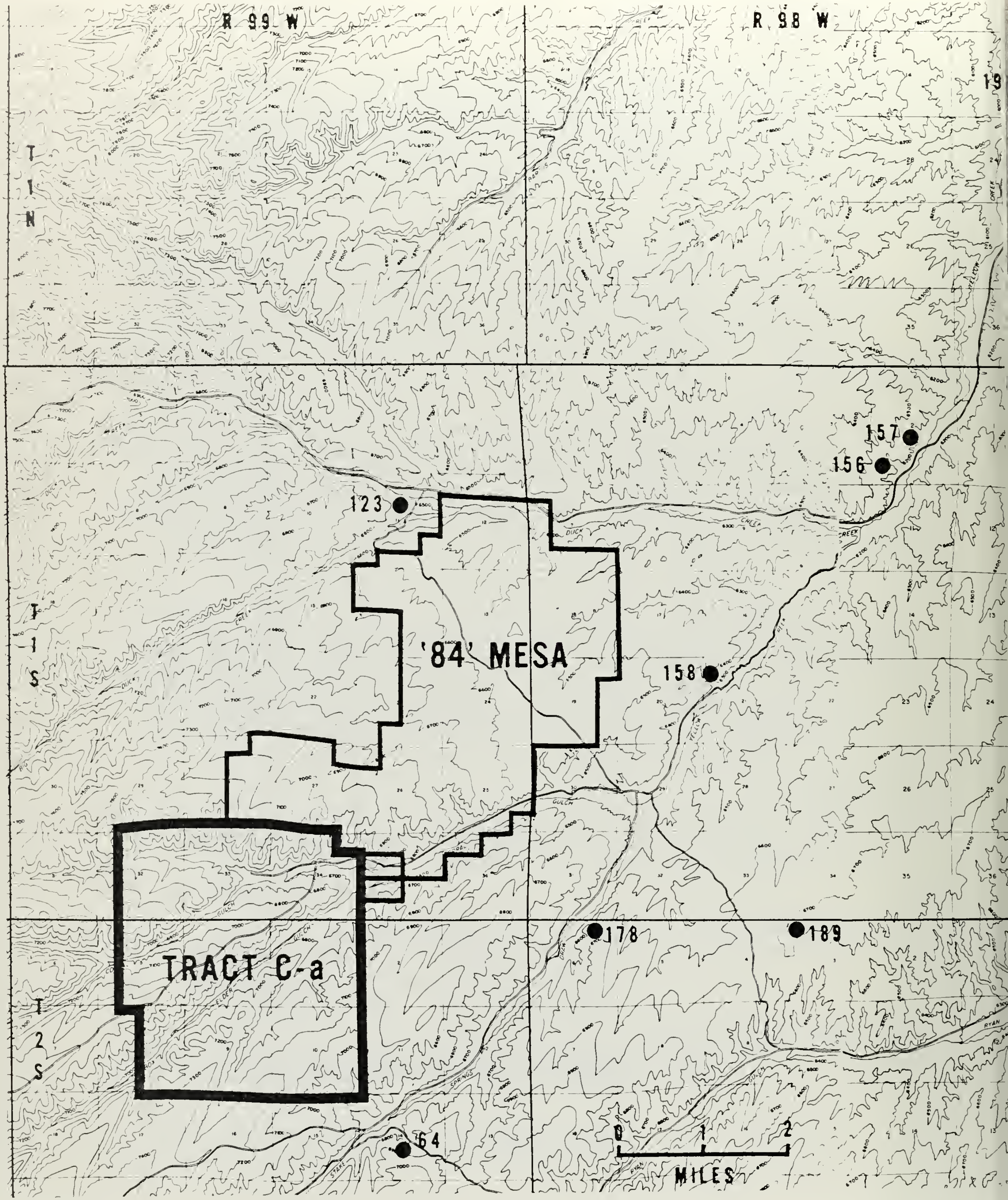
During the archaeological survey assessment performed for RBOSP on and in the vicinity of Tract C-a and 84 Mesa, field survey teams located a total of 196 archaeological sites and 1 historic site (Olson, et al. 1975, p. 14). At eight of these sites, shown on Figure 2.5.8-1, fragments of petrified wood and vertebrate remains were found. These were furnished to RBOSP for paleontological investigations.

The "paleo-finds" were forwarded to Dr. Paul O. McGrew, vertebrate paleontologist, University of Wyoming for identification and assessment of their paleontological significance. Emphasis was placed on determining if any of these fossils were paleontologically unique or rare as compared to fairly common or abundant fossils found throughout the Piceance Creek basin in particular and throughout the Tertiary basins of the tri-state area of NE Utah and SW Wyoming in general.

2.5.8.3 Results

Dr. McGrew's report dated March 26, 1976 is summarized below:

Site No.	Identification
64	Fossil fragments of a uintathere vertebra, probably of the genus Eobasileus (Eocene, Uinta Formation).
157, 158, 196	Fossil fragments of turtle carapace or shell, genus not identifiable (probably Eocene, Uinta Formation).
123, 156	Fossil fragments of mammal bone, genus not identifiable (probably Eocene, Uinta Formation).



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● Archaeological sites (8) at which 'Paleo-Finds' were located.

Figure 2.5.8-1 "Paleo-Finds" Map

Site No.	Identification
158	Fragments of petrified wood, not identifiable.
178, 189	Mammal bone scraps, not fossil, showing evidence of burning, probably by the archaeological sites' former inhabitants, identified as deer and bison bone.

Dr. McGrew concludes, "In themselves, none of these specimens is of paleontologic or stratigraphic significance. Turtle scraps are omnipresent in both near-shore and fluvial Eocene sediments of the entire Rocky Mountain area. Uintatheres are well known from the Bridger basin, the Washakie basin, the Sand Wash basin, etc. Scraps of fossil wood, too, occur throughout near-shore and fluvial Eocene sediments of the region".

"In summary, on the basis of this collection, I would consider the area of doubtful paleontologic significance. The Piceance Creek basin was probably not environmentally suited for an abundance of Eocene mammals. Certainly with the great amount of geologic work that has been done in the Piceance Creek basin, more evidence would have appeared by this time."

The Uinta Formation forms the bedrock at all eight archaeological sites where the fossils were located. All fossils were found lying loose on the rocky soil-covered ground with none attached to bedrock. However, they may have weathered out of bedrock at or near the sites. Therefore, no firm evidence exists that the fossils are or are not indigenous to the sites at which they were found.

There is a possibility that early man may have collected some of the fossils out of curiosity from various areas, brought them to the sites and subsequently discarded them. This possibility is supported to some degree by the fact that few fossils were found by the archaeological survey teams in a relatively large area. However, early man did make use of petrified wood. Olson, et al., (1975, p. 47) reports that petrified wood accounts for about 8% of the material from which tools were made by aboriginal inhabitants of the study area.

Although a significant paleontological discovery is always a possibility during any excavation on or adjacent to Tract C-a, that possibility is considered extremely remote based on the data compiled.

The "paleo-finds" are stored at RBOSP offices in Denver, for future reference and viewing by interested parties.

LITERATURE CITED

Olson, A.P., T.G. Bridge, C. Craig, B. LaFree and S. Steenrod. 1976. An archaeological survey assessment for Rio Blanco Oil Shale Project 1975. Univ. of Denver. 136p.

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